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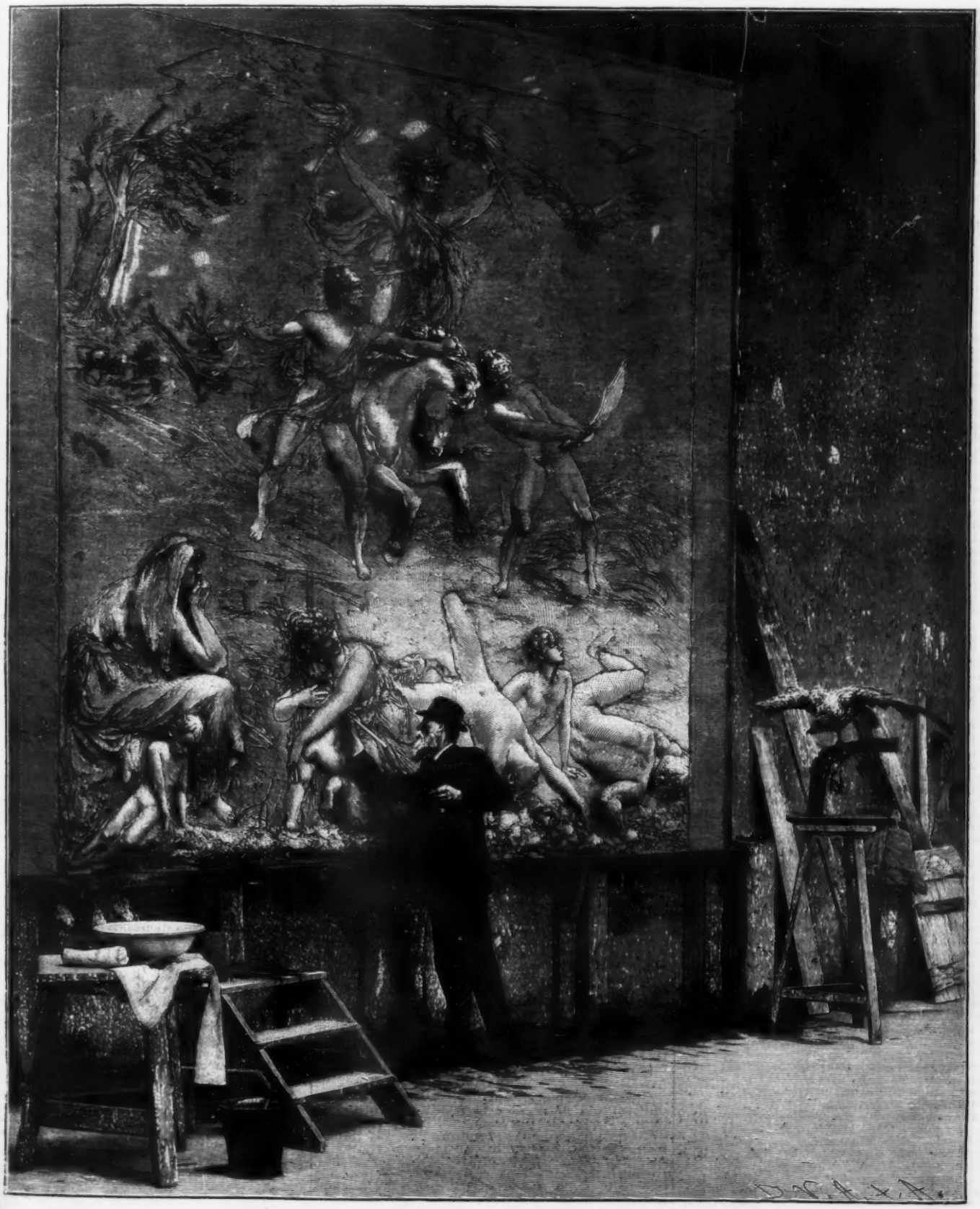
PROF. BEGAS IN HIS ATELIER.

THE illustration shows Prof. Reinhold Begas at work on the bass relief "War," which is intended for the national monument to be erected in the city of Berlin for Emperor William I. The monument is approaching completion and will be unveiled at the centenary of Emperor William's birthday, March 22, 1897. Many statues have already been sent to the foundries from the artist's atelier. Prof. Begas bestows especial care upon the completion of the reliefs which will adorn the broad sides of the monument's pedestal. One of these reliefs represents Peace and the other War. The artist himself gives the finishing touch to these compositions, which are worked in high relief, but still show soft, delicate lines. An allegorical figure will be placed on the steps below each of the reliefs to harmonize with the reliefs.

The huge dimensions of the monument and of the reliefs may be realized from the fact that the professor's atelier had to be altered entirely: it now has about the height of a two story building, and yet this has only been just sufficient to permit of placing in it the equestrian statue of the emperor.



PROF. BEGAS WORKING ON THE GREAT BASS RELIEF "WAR," FOR THE MONUMENT IN HONOR OF EMPEROR WILLIAM I.

COMPRESSED AIR FOR CITY AND SUBURBAN TRACTION.*

BY HERMAN HAUPT.

ALTHOUGH a considerable amount of compressed air literature has been given to the public during the last two years, there is still a want of information as to the efficiency and economy of air motors as compared with cable, electric and other systems, and statements are continually published in the columns of the daily press that exhibit ignorance of scientific facts and apprehension of imaginary dangers.

Compressed air motors have been in successful operation in France for many years, and they are now rapidly establishing themselves in public favor in the United States. They have been constructed and tested at Rome, New York, continuously for two years, in all conditions of weather, and have given satisfaction even at temperatures below zero. Several motors are now, and have been, running for some months on the One Hundred and Twenty-fifth Street Railway, in the city of New York, in daily service, without having lost a trip and with great satisfaction to the public.

The attention of the writer was first directed to the use of compressed air for city service in 1879, when he was called upon to examine, test and report upon several motors that had been constructed under the supervision of Robert Hardie, and allowed to be run on a portion of the Second Avenue Surface Railway, at Harlem, in New York. These motors were tested for several weeks, and the results were entirely satisfactory; but all attempts to secure their introduction proved fruitless. There was so strong a prejudice against them that the president of one of the city railroads in Philadelphia declared that he would not have such a motor on his road if it saved the whole cost of horse power; that it would frighten every team on the street to see a car running without horses, and the company would be perpetually annoyed by lawsuits. Explanations proved useless, and efforts were abandoned.

After the far more objectionable and expensive cable and trolley systems had been introduced and had demonstrated that a car could be run without horses and without frightening teams, the writer renewed efforts to educate the public, and especially the profession, in regard to the superior merits of compressed air. A book was published, giving a description and comparative cost of all the systems known or used for city traction, based on similar conditions of service.

This was followed by a number of monographs on special points, and finally resulted in the formation of a syndicate to raise capital and organize a company under the title of the General Compressed Air Company. The services of Mr. Robert Hardie were secured as engineer, and a motor constructed at the Rome Locomotive Works, which proved entirely successful from the start, and has been examined, tested and favorably reported upon by engineers, experts and scientists from all parts of the United States without exception.

Very erroneous opinions have been and are yet entertained in regard to the power lost in compressing air, the frost produced in expansion, the danger of explosion, the reheating of dry and moist air, the cost of plant, the necessity for frequent renewals of air supply, the possible length of run, the loss by transmission of air to distant points, and other matters connected with the practical application of air as a motor power.

That the subject of air motors may be intelligibly presented, it is necessary to state briefly some of the properties of air and the laws which govern its compression, expansion and distribution, also such of the properties of steam as enter into the consideration of the questions at issue.

PHYSICAL PROPERTIES OF AIR AND STEAM.

Air at a temperature of 32° F. requires 12·433 cubic feet to weigh 1 pound; at ordinary temperature about 13 feet.

The weight of steam at 212° is 26·4 cubic feet to the pound, or approximately, for rough calculation, 26 feet. Specific heat, or capacity for heat, varies with different substances, and it is a very important element in calculations in thermodynamics. Water, having the greatest capacity for heat, that is, having a capacity to retain the greatest number of heat units per pound, has been taken as the unit of specific heat. On this standard, the specific heat of air is 0·2377, or approximately 0·24.

The specific heat of steam is 0·475, or approximately 0·48, or double the specific heat of air. In other words, steam is half as heavy as air, but has double the capacity per pound for retaining heat.

If air be suddenly compressed to one-half its volume, the temperature will be raised 116°, and if suddenly expanded to double its volume the temperature will be reduced to the same extent.

Under high pressure a given increase of pressure will develop much less heat than at low pressure. For example, a given volume of air at atmospheric pressure, condensed suddenly to one-half by an increase of pressure of 15 pounds, would develop 116° of heat, while under a pressure of 25 atmospheres an increase of pressure of 1 atmosphere would raise the temperature only 16·7°.

A thermal unit, or unit of heat, is the quantity of heat that will raise the temperature of 1 pound of water 1°, and a thermal unit is the equivalent in work of 772 pounds raised 1 foot.

A horse power is 33,000 pounds raised 1 foot in 1 minute.

Isothermal compression is compression without evolution of heat. If this were attainable in practice, as much energy could be utilized in the expansion of air as was expended in compression.

Adiabatic compression is compression with evolution of heat. By compression and intermediate cooling it is claimed that 80 per cent. efficiency may be obtained. Under old systems of compression the loss has been conceded to be 50 per cent. The capacity of air for holding moisture is affected by volume and temperature, but not by density. A cubic foot of air will hold no more water at the same temperature under 133 atmospheres than under 1; consequently, when this air is expanded to original tension, 1 cubic foot will contain only $\frac{1}{133}$ part of the moisture that it had originally and should be too dry to form a deposit of ice at the exhaust, even if not reheated. Only low pressures can contain sufficient vapor to cause trouble; but as air should always be reheated, for reasons that will be explained, the difficulty from frost is purely imaginary.

Absolute or theoretical zero is a point determined by theory 461° below the zero of Fahrenheit, from which temperature must be estimated in problems connected with expansion of elastic fluids, the volumes being in proportion to the temperatures from absolute zero. This datum will be found essential in considering the question of reheating.

Latent heat is the heat that disappears or becomes latent on change of form, as from a solid to a fluid, or from a fluid to a vapor, and which reappears by condensation when the original condition is resumed.

In the liquefaction of ice 142·5 units of heat per pound become latent, and in the conversion of water into steam 966 units; so that the latent heat of water from ice is 142·5 units and of steam 966°.

The specific heat of ice is 0·50, so that the number of thermal units in 1 pound of steam at 212°, measured from absolute zero, will be $(461 + 32) \times 0{\cdot}50 + 142{\cdot}5 + 180 + 966 = 1{,}535$ units.

An apology for these explanations and definitions seems to be required, as they apparently assume a want of information on the part of the reader, but there seems to be a necessity for explanations to remove the ignorance and prejudice that are almost universal. Even in technical journals articles have appeared from the pens of gentlemen of high scientific reputation advocating the reheating of dry air to increase its power, and giving plans of apparatus for the accomplishment of this object. It will be shown that to double the power of dry air by an application of heat is practically impossible, and that it is only by an admixture of vapor that satisfactory results can be secured, yet this demonstration could not be given without furnishing the data which it required.

AIR COMPRESSORS.

The use of compressed air for the operation of rock drills and for other purposes has become so extensive that it has led to great improvements in compressors, and several companies are now engaged in their manufacture who will furnish plants at moderate prices and guarantee results. Among these can be named the South Norwalk Iron Works Company, the Ingersoll Sergeant Drill Company and the Rand Drill Company. The best results are secured by repeated compressions with intermediate cooling, and large plants should always consist of a number of units, so that repairs to one will not affect the remainder, and the number in use at one time can be regulated by the demands of the traffic.

The experience gained by numerous tests, extending over a period of years, has furnished positive and reliable data by which to determine the amount of free air, under compression, required for any given service under any ordinary conditions. If responsible manufacturers of compressors will agree to furnish the plant at a given price, with a guarantee to compress a given number of cubic feet of free air per minute, delivered in station reservoirs under a given pressure, with a coal consumption and horse power within prescribed limits, all elements of uncertainty as to cost of power seem to be removed; and this is being done.

The improvements in compressors have greatly increased their efficiency and extended the use of compressed air. In the primitive types an efficiency of 50 per cent. only could be secured; now 80 per cent. is claimed, while the ability to transmit power by this agency to long distances without serious loss, and to concentrate many small powers into a general reservoir will permit many water powers to be utilized that would otherwise be worthless, and secure economies not offered by any other system.

The sudden compression of air is attended with a great evolution of heat. To compress two volumes of air into one, as previously stated, will raise the temperature 116°; but it is a remarkable and valuable property of air and other elastic fluid that under high pressures a given increase requires less power and develops less heat than under low pressures.

If, for example, it should be required to compress 3,600 cubic feet of free air per minute to a pressure of 500 pounds, the horse power required would be 1,060 horse power; if to 1,000 pounds, the power would be 1,219 horse power, a difference of 159 horse power for 500 pounds; if to 1,500 pounds pressure, 1,288 horse power, or a difference of 69 horse power for 500 pounds; and if to 2,000 pounds, 1,339 horse power, or a difference of only 51 horse power to gain 500 pounds of additional pressure.

The power required to compress 1 cubic foot of free air is estimated as follows:

	Horse Power.
To 500 pounds pressure per minute	0·316
To 1,000 " " "	0·364
To 1,500 " " "	0·385
To 2,000 " " "	0·400

To which 10 per cent. allowance should be made in practice in allowing actual power for compressors.

Mr. E. Hill, the general manager of the Norwalk Iron Works, gives absolute isothermal compression to 2,000 pounds per square inch per cubic foot of free air per minute, 0·315 horse power, and the best possible in practice under the most favorable conditions, 0·378 horse power. The computation of the writer gave 0·348 horse power as the theoretical isothermal, but 0·45 should be allowed in practice. It is better to provide an excess of power than to suffer the inconvenience of a deficiency.

REHEATING.

A remarkable property of compressed air is that its efficiency can be doubled by reheating. This is not theory; the fact has been confirmed by actual demonstration both in Europe and America. It may appear incredible and contrary to well-known physical laws that the efficiency of air can be doubled by simply passing it through a tank of hot water before admission to the motor cylinders; but such is the fact, and the reheating which doubles the power represents a consumption of coal only one-eighth of the amount required at the power station to produce the compression.

A direct test was made at Rome, on motor No. 109, in the presence of Capt. G. J. Fiebeger, of the United States Engineers, now professor of civil engineering at West Point. The consumption of reheated air from an average of many runs was 308 cubic feet per mile. When the reheater was emptied of water, the volume of cold air required was 669 cubic feet per mile.

An explanation of this remarkable result will be given.

A comparison will be made between the results of reheating dry air to an extent sufficient to double its volume with and without the assistance of water, assuming the volume at 60° to be 300 cubic feet of free air, and that it is to be admitted to the motor cylinders under a pressure of 150 pounds to the square inch.

Assume, in the first place, that air at 60° is passed through a tank of water at 360°, giving a steam and air pressure of 150 pounds per square inch. The units of heat required to double the volume will now be determined.

The absolute temperature at 60° is $60 + 461 = 521°$.

The absolute temperature at 360° is $360 + 461 = 821°$, so that the air passing through water at 360° will be increased in volume, or under constant volume will be increased in pressure 63 per cent.

The thermal units required for the increase of temperature will be 23 pounds of air raised 300°, specific heat of air being 0·24. Then $23 \times 300 \times 0{\cdot}24 = 1{,}656$ units. The air has been increased in pressure 63 per cent., and to double the pressure by the addition of vapor or steam from the water will require the addition of 111 cubic feet of steam at atmospheric tension.

That is, the 300 cubic feet of air at atmospheric tension has been increased to 489, and $489 + 111 = 600$. The 111 cubic feet of steam weighs 4·3 pounds, to secure which from water at 360° requires only the latent heat, or 863 units. $863 \times 4{\cdot}3 = 3{,}711$, and adding the 1,656 units previously obtained will give a total of 5,367 units.

Coal completely consumed will furnish 13,000 units per pound, petroleum 20,000 units per pound, and allowing for loss by imperfect combustion, 1 pound of coal or ½ pound of petroleum should furnish the fuel for reheating at a cost of 2 mills for coal or 1¼ mills for crude petroleum, and 300 cubic feet of air thus reheated should run an eight ton motor much more than one mile.

To double the volume of air by the application of dry heat, the temperature must be double from absolute zero. At 60° observed temperature the absolute temperature would be $60 + 461 = 521°$, and the double would be 1,042°, and deducting 461° would leave the equivalent thermometric temperature 581°, a degree of heat that would burn out the lubricants and would be entirely inadmissible. In fact, it is stated in a recent work on compressed air by Mr. Frank Richards that to double the power with dry air would require a temperature of about 800°, in consequence of the low specific heat of air and consequent rapid cooling.

As the air is supposed to be used expansively, so that the atmospheric tension is reached at the end of the piston stroke, the quantity of heat lost by expansion with an initial pressure of 10 atmospheres, or 150 pounds, would be 494°, which is nearly all that the heated air contained, so that if the admission could be at 581°, the exhaust would be 87°, without allowance for loss by radiation or conduction, and so much heat would be absorbed by the cylinder that the efficiency of the reheated air would be greatly impaired.

On the other hand, if the air is passed through hot water, any vapor condensed in the cylinder yields its latent heat and steam, also acts as a lubricant.

Another striking comparison will be presented. Steam at 350° temperature and 150 pounds pressure will, in cooling down to 212°, impart more than thirty times as much heat to the cylinders as an equal weight of air between the same temperatures.

The difference of temperature is $350 - 212 = 138°$.

Specific heat of steam, 0·475; air, 0·24.

	Units.
1 pound of steam yields $138 \times 0{\cdot}475$	65·5
and of latent heat	966·0
Total heat from 1 pound of steam	1,031·5
1 pound of air reduced 138° yields $138 \times 0{\cdot}24$	33·12

One pound of steam carries as much heat as 31 pounds of air, and not only serves with little loss to maintain the cylinder and passages at a proper temperature, but, as previously stated, it also serves as a lubricant.

The reasonable conclusion is that it is practically impossible to heat dry air to an extent sufficient to double its power, and, if practicable, it would be inexpedient and the effect highly injurious.

The ideal reheater would be a tank containing water at a temperature to furnish steam at the pressure of the air as used in the motor cylinders. The heat retained constant and uniform by cheap fuel, such as crude petroleum, and in winter the cars to be heated by water circulation from the same tank.

From tests made by him in 1879, the writer concluded that the average amount of water absorbed by the air and carried over in the form of steam was about 1 pound for 50 cubic feet of air. The accuracy of this result having been questioned, Mr. Hardie was requested to make a series of tests at Rome, the result of which established the fact that the quantity of water absorbed and carried over was dependent upon the temperature. At a high temperature in the water a comparatively small volume of air would suffice to evaporate a pound, and at a low temperature the volume of air was greatly increased.

The following table is interesting, showing the number of cubic feet of air at atmospheric tension required to absorb and carry over 1 pound of water in the form of steam or vapor:

Degrees F.	Cubic Feet.
At 321	35·2
At 300	42·5
At 296	43·3
At 274	48·5
At 259	95·2
At 210	159·0
At 190	238·0
At 182	229·0
At 170	221·0
At 164	459·0
At 158	493·0

* Published in the Journal of the Franklin Institute.

RESERVOIRS.

The subject of reservoirs is one of the most important in connection with the construction of compressed air motors. The reservoir is the source of power in the motor, and upon its capacity and strength the possible length of run depends. Formerly, reservoirs were constructed of riveted boiler plates, and were capable of sustaining a pressure of from 300 to 600 pounds per square inch only. Consequently, a run of over 10 miles required so great an extension of capacity that room could be secured only by raising the floor to an inconvenient height above the rails. To secure long runs with moderate reservoir capacity high pressure is a necessity, and reservoirs are now manufactured by a peculiar process from solid ingots of mild steel, without a joint or weld, and which are capable of sustaining with safety a pressure of 2,000 pounds per square inch, the test, within the limits of elasticity, being carried to 4,000 pounds, leaving so large a factor of safety as to render rupture impossible.

It is proper to observe that the risk of rupture is not greater under a pressure of 2,000 pounds than it would be under 500 pounds, for the thickness of the shell would be four times as great with the higher pressure, and the strain per square inch of metal would be precisely the same in both cases.

Paradoxical as it may seem, it can be shown that a pressure of 2,000 pounds per square inch is actually more safe than a pressure of 500 pounds, notwithstanding the fact that newspaper scribblers, in the interest, apparently, of rival systems, to create a prejudice against compressed air, magnify the risks of an explosion and the dangers to result therefrom.

Bear in mind that all reservoirs intended to carry 2,000 pounds are tested to 4,000 pounds, within elastic limits; consequently, the pressure could be increased 2,000 pounds more before the danger limit could be reached.

But if the pressure were 500 pounds the margin of safety would be the same, and the test would be to 1,000 pounds. Consequently, a variation of 500 pounds increase of pressure would reach the danger limit with the low pressure reservoir, but would be 1,500 pounds below this limit with the high pressure. There can be no question of the sufficiency of the margin of safety.

But if, notwithstanding the theorizing upon the subject, the reservoirs should actually burst, would not the consequences be disastrous? The answer is NO! A rent would be formed and the air would escape with a hissing noise. The material, unlike cast iron, is ductile and will stretch and pull apart and not fly in pieces.

The following extract from a letter from the manufacturers in Germany, addressed to the writer, will afford an explanation:

"Regarding the reservoirs, we put them to a test yesterday to state the elastic limit. It was reached at 3,500 pounds, but we went further in our experiments in order to demonstrate by practical test (as it has been demonstrated in hundreds of bursting tests of carbonic acid bottles) that these air bottles would not crack or fly to pieces, but that they would simply open when the breaking strain was reached (as was always the case with the carbonic acid bottles, when tested to bursting strain) and allow the contents to flow out, proving thereby that the handling of these bottles is in no way dangerous. We, therefore, think it advisable and safer for the future practical use of the bottles, not to test them, as we mutually agreed, till near the bursting strain, but only till near to the elastic limits, because we are afraid that although they stand the test till near the bursting strain, the metal is somewhat weakened and, therefore, the practical use afterward diminished. You will find the bottles somewhat lighter than ordered, and the question to decide for future deliveries will be whether you want the bottles as light as possible and use a storage pressure of 1,500 pounds per square inch, or if you prefer to make them somewhat heavier and use a storage pressure of 2,000 pounds per square inch. Please answer if you agree to the above, and we will send you the whole lot immediately. To-day we send you eight botties, seven medium long and one short one, that you may, if you choose to do so, repeat the test to 3,500 pounds. As the fluctuations of the compressed air pressure, caused by the fluctuations in the atmospheric temperature, are small when compared with the same fluctuations of the carbonic acid, we think it safe to test the air bottles only to the elastic limit, and use them with about half that pressure in practical work, as this way is safer than to test the bottles to the bursting strain and charge them only with one-third of that pressure afterward in practical use."

Similar results have been indicated by tests in other localities, and it must be remembered that the rupture of a cylinder containing air produces effects that are widely different from those which result from the explosion of a steam boiler. When a boiler explodes, the volume of steam may be instantly increased more than a thousandfold by the conversion of water into steam by the reduction of pressure, the boiler is ruptured and pieces of iron and scalding water projected to great distances, while the rupture of an air cylinder allows a comparatively moderate expansion of the contents, accompanied by a sensation of cold and not of heat.*

(To be continued.)

Paris has had its first genuine automobile accident, the twenty-five liter oil tank of one of these carriages having caught fire and blown up on the Boulevard Haussman, near the Grand Opéra, one evening recently. No one was hurt.

*To illustrate more clearly the effect of the explosion of a steam boiler, let it be assumed that the dimensions of the boiler are 3 feet diameter and 12 feet long, containing 85 cubic feet, of which 70 cubic feet are water and 15 cubic feet of steam at a temperature of 359°.

The 70 cubic feet of water will weigh 4.375 pounds, and at 359° will contain 1,581,250 units of heat.

The 15 cubic feet of steam at 15 atmospheres will weigh 9 pounds and contain 10,622 units, and the whole contents of the boiler 1,541,870 units of heat.

Let x = quantity of water at 212° not converted into steam by the explosion. Then $4.375 - x$ = water converted into steam at 212°. Latent heat, 966 units. Then $212 + (4.375 - x)\ 966 + 10,602 = 1,541,870$. From which $x = 3,600$ pounds, and $4.375 - 3,600 = 775$ pounds of water converted into steam by the explosion = 20,176 cubic feet, $20,176 + 225 = 20,401$ = cubic feet of steam liberated, and $20,401 \div 15 = 1,360$ times the original volume of steam which has been increased by the explosion.

STREET TRACTION IN FRANCE.

B. ABDANK, a consulting engineer of Paris, who has had wide experience of different methods of urban car traction, sailed to Europe a short time since, after a brief business trip to this country. Before leaving, M. Abdank said:

"In France, after experiment of every conceivable mode of traction, the problem is definitely solved by the adoption of the trolley electric system. By this I do not mean the overhead trolley exclusively, but, in the crowded parts of cities, the underground trolley as well.

"We got our tram cars from the United States about twenty-five years ago. Previous to that time we had only omnibuses. I may add that we still have many omnibuses. You have in New York banished the omnibus from all your thoroughfares except Fifth Avenue. In Paris the omnibus alone is still permitted in the crowded centers of the city, and there is no immediate prospect of a change in many of those central boulevards. The Parisian people have always had and still have an intense repugnance to seeing their principal streets and most beautiful boulevards seamed with car tracks. The tram cars we got from America remained in universal use throughout France until three years ago. Then only did their general displacement by electric cars begin. It is not to be inferred from this that we were supine in the matter. On the contrary, we were more diligent in experimentation than probably any other nation. We were behind you in experimenting with electricity, however, and when we saw that you had advanced it to a point where its feasibility would be speedily demonstrated in a practical way, we rather held back to watch you and let you decide the question for us. But in trying other modes of traction we were before you. We have most thoroughly tested ordinary steam, superheated steam and compressed air. There are a few short lines in France, Belgium, Spain, and other European countries still operated by the superheated steam system; but that system is dead, it is only continued because of the great cost of changing it, and because in the peculiar localities in which it is used the expense of a change does not seem to the managers to be justified.

"The compressed air system is in larger use, but the same judgment may be pronounced upon that. This subject is one of importance to you because you seem to be looking to this system with considerable hope just when it has been practically discarded in France as undesirable. There, as here, it was hailed by a good many people as the solution of the whole problem, and it held its own very well until the appearance of electric traction. Not a few companies in France were prepared to introduce the compressed air system when the development of electric traction in this country and its first successful introduction in France caused them to suspend action until they had further watched the operation of electricity. Their final decision was in favor of the latter system. The status of the several systems in France is concisely shown by the fact that, beginning only three years ago, we have built five hundred miles of trolley line, while of the compressed air lines there are only forty-one, although the system was introduced in 1881, and a still smaller number of miles of the superheated steam system.

"There are two main reasons why compressed air traction has gone to the wall and electric traction has come into such wide use: the greater cheapness of the latter, and its greater simplicity. The compressed air system involves a large number of transformations of energy whereby power is lost and the expense of the operation greatly increased. The purely traction cost of this system is ten and a half cents per car mile; the purely traction cost of the trolley is five and a half cents a car mile, just about half. Again, the compressed air system involves mechanism of a highly complicated order. There are fifty moving parts in an air motor car; in the electric there are only the armature and gear. Whatever is complicated is upon general principles objectionable in mechanics; the simpler a thing is, the more desirable and useful. Complicated constructions get out of order easily, and the cost of repairs is great. The repair cost of the air motor cars in France has been something enormous. The air motors proposed in your country may have some improvements over the method invented by M. Mekarski in France; but they cannot be radical. I confess that I did not examine the cars you have in operation here on One Hundred and Twenty-fi th Street; but the reason is that, as an engineer, I have studied the principle thoroughly and know that it is incapable of any substantial development. So far as I have heard, the only difference of any moment between the air motors here and those in France is that here you propose to operate under a very much higher pressure of air than we use there. But this, while not increasing the efficiency of the system to an adequate extent, and not removing the objections founded upon complexity and cost, is highly dangerous. With the much lower pressure used in France we have had many accidents. Tanks, pipes and valve boxes have at one time or another exploded. I have personally seen two explosions. What would be the result with the pressure doubled? Since the practicability of the trolley was demonstrated there has not been a single compressed air line added to those already in France.

"The city of Paris itself is quite behind other cities in France in modern methods of urban travel. We are still in the stage of omnibuses and horse cars, while Havre and Rouen are networked with trolleys, and Lyons is constructing them, and Bordeaux has made arrangements to effect a total change. The reason of our backwardness lies in the fact that our means of travel are in the hands of a monopoly—the Compagnie Generale des Omnibus—which must surrender its privilege in twelve years. Naturally the company will not make a vast expenditure when in twelve years its monopoly ceases, and all its railway and omnibus property, under the terms of its contract, passes into the possession of the city. The company has sought a renewal of its monopoly, but this has thus far been refused, and there is no likelihood of its being subsequently granted, for there is an almost unanimous popular outcry against it. The company has next proposed to change the whole tramway system from horse power to electric power in consideration of an annual grant from the city sufficient to reimburse them for the outlay. It seems probable that some such arrangement will be made, and in expectation of it the company has invited estimates from the leading electric companies throughout the world. The probability, therefore, is that within a few years Paris will be covered with electric lines just as some of your American cities are. While there is not the same outcry with us against the overhead trolley that there is in this country, it is not likely that it will be permitted in main thoroughfares in Paris or in the central part of the city. The underground trolley will probably be used there, and the overhead trolley in the less settled parts and through the suburbs. At the same time, there are certain thoroughfares and boulevards which will remain, for some time at least, sacred to the omnibus. I should add that this company only last year experimented with the compressed air system and discarded it. It also tried the storage battery system, which has met with as little favor in France as here. The underground trolley, while having some objections from which the overhead is free, is essentially the same thing and equally practicable. In Budapest they have had underground trolley lines in satisfactory operation since 1886.

"Although the cable system is in wide use in your country, I think it is not too much to say that all progressive engineers and railway men look upon it as really antiquated and doomed soon to become obsolete. We have tried it in Paris, not as extensively as you have, but enough to satisfy us that its day is virtually over. Our little cable line in Paris, through Bellville, furnishes our comic journals with perpetual jokes."—New York Evening Post.

THE EMBANKMENTS OF THE RIVER PO.*

THERE is probably no part of the world in which the action of rivers in carrying and depositing sediment can be better seen and more readily studied than in the plains of Lombardy and along the adjacent shores of the Adriatic, and no district has contributed more to our knowledge of the important subject of river action and delta building than has this portion of Northern Italy.

In this well settled country the very rapid advance of the land upon the sea everywhere has been especially remarked and could not escape the attention of the most unobservant, since, as is well known, the very town of Adria, which gives its name to the Adriatic Sea and which was a seaport in the time of Augustus, now lies fourteen miles inland.

One statement concerning the chief of these Lombard rivers, the Po, taken from chapter eighteen of Lyell's Principles of Geology, has been copied and recopied in one generation of textbooks after another, a statement so remarkable that wherever met with it always arrests one's attention. It is that in which, after speaking of the action of the dikes, between which these Lombard rivers are confined, in causing a portion of the sediment, which would otherwise be spread over the plains by the annual inundations, to settle in the bottom of the river channel, with the consequent necessity of from time to time increasing the height of the dikes, he says, "Hence it happens that these streams now traverse the plains on the top of high mounds, like the water of aqueducts, and at Ferrara the surface of the Po has become more elevated than the roofs of the houses."

On reading this passage one cannot but tremble for the fate of the city should the river break through its dikes, as it has already done on several occasions, and, being precipitated into the city, tear its way headlong to the sea.

A visit to Ferrara toward the end of May last served, however, to show that this danger is less imminent than might be supposed from Lyell's description.

The city of Ferrara has seen its best days; its population, once numbering 100,000, has now dwindled away to less than 30,000, while great stretches of land within the walls are now quite deserted or used as kitchen gardens. The broad and ample streets and fine squares, as well as the noble cathedral, the numerous palaces and the great castle of the House of Este, however, serve to remind us of the former greatness of the city, with which are so intimately associated a number of the most distinguished names in Italian history, Savonarola, Ariosto and Tasso among the number.

The city is situated in the middle of the great plain of lower Lombardy, which, so far as the eye can judge, is absolutely flat and which here is only six and a half feet above sea level. The walls of the city, built of brick—for no good building stone is to be had in the alluvial plains in this vicinity—rise abruptly from the plain and are of no great height.

The plain all about Ferrara is very fertile, well cultivated and of extreme beauty, being intersected at regular intervals by long lines of poplars and pollarded elms festooned with vines, which also border the roads and separate the meadows and great fields of grain and hemp. The roads crossing the plains are well made and are raised considerably above its general surface, thus keeping them dry and in good condition.

The river Po, however, does not pass through the city of Ferrara, although it formerly passed near the city and in this vicinity branched, forming the Po Primario, whose mouth was at Ravenna, and the Po Volano, which debouched into the northern portion of lagoon of Comacchio. In the year 1152, however, the river broke through its dikes at Stellata, twelve miles and a half northeast of Ferrara, and took a new course in the direction of the Venetian lagoons, which course, with some minor modifications, it has retained to the present time. By this change the Po Primario and the Po Volano were deprived of a great portion of their water, and the main stream now passes three miles and a half to the north of Ferrara, where it is crossed by the railway to Padua, at the little town of Ponte Lago Scuro, a busy little place, which is the chief port on the lower reaches of Po and which is connected by a bridge of boats with S. M. Maddelena, a village on the opposite bank of the river.

On approaching Ponte Lago Scuro from Ferrara the dikes which confine the river are first seen, crossing the flat country like a wall. The road at Ponte Lago Scuro is carried by a long incline nearly to the top of the dike, the upper portion of which is cut through to allow the road to pass, and then by a steep descent on

*From Science.

the inner side of the dike the bridge of boats is reached, after crossing which, by a steep rise and then a gentle descent, the plain beyond the river is once more gained.

The Po at this point is two hundred and eighty-five yards wide, with a swift current sweeping rapidly by the boats, and the water at the time of my visit was very turbid from suspended mud, although it did not appear so turbid as the Arno at Florence or Pisa, and certainly not so muddy as the Missouri at Bismarck.

Watching it from the bridge as it sweeps by already near the sea and far from its source on Monte Viso, carrying great quantities of leaves, masses of weeds and branches of trees floating on its surface, a very vivid impression of the work which is being accomplished by the river is obtained. Although nothing in the way of actual erosion can be seen, no mountains or rising ground anywhere breaking the monotony of the plains. The long sand bars, seen from the top of the dikes, in the wider stretches of the river just above Ponte Lago Scuro, show that in flood time a large quantity of material too heavy to be carried in suspension is swept along.

The dikes or embankments which confine the river on either side are about 25 yards wide and rise in two, or sometimes three, terraces as approached either from the plain or from the river, as if a wide dike of moderate height had just been made, along the summit of which a narrower dike had subsequently been raised. The height of the dikes was estimated to be about 26 feet, and being well grassed over, they do not present that strikingly artificial character which might be expected. An excellent road runs along the summit of the southern dike. The dikes thus, although not so high as the majority of the houses in the villages on either side, overtop the smaller houses and outbuildings, while, standing on the bridge at the middle of the river, seven feet above the level of the stream, only the roofs and upper stories of the buildings on either side of the river can be seen.

With regard to the level of the waters of the Po as compared with that of the adjacent plains many contradictory statements have been made. The statement of Lyell that at Ferrara it was as high as the roofs of the houses was derived from Cuvier's "Discours sur les Révolutions de la Surface du Globe," although not quoted quite correctly, where the statement is made on the authority of M. De Prony, an inspector general of bridges and roads, who had been directed by the government to investigate the means of preventing the disastrous floods caused from time to time by the Po overflowing its banks.

These very old observations were subsequently shown by Lombardini in 1847 to be erroneous. This observer proved by accurate measurements that, at the time these were carried out, the mean height of the Po only here and there rose above the level of the plains and was generally considerably below it, and that even during the great flood in 1830 the surface of the river was scarcely ten feet above the pavement in front of the Palace at Ferrara (Geikie, Textbook of Geology, p. 368).

Since this time, however, these conditions have altered in a marked manner, the more recent investigations of Zollikofer having shown that in the normal condition of the river the surface of the water in the neighborhood of Ferrara is somewhat over 8 feet above the surrounding plains, while in flood time the water in some places rises from 16 to nearly 20 feet above the plain on either side (Kovatsch, "Die Versandung von Venedig," Leipzig, 1882, p. 35).

At the time of my visit the surface of the water was certainly higher than the level of the plains, and the deep furrows in the dike on the left bank of the river showed that in flood time the river now rises at least as high as the top of the first terrace of the embankment, which would be equivalent to the height given above by Zollikofer. That the river at times threatens to rise even higher is shown by the fact that where the upper terrace of the dike is cut through to allow the passage of the road from Ferrara a brick wall has been constructed, so arranged that by the insertion of planks the highest level of the dike may be maintained.

The city of Ferrara, therefore, although it might be subjected to disastrous inundation should the dike on the right bank of the river break, is not so seriously threatened as might be inferred from Lyell's statement, and the Po, which in flood time "hangs suspended, so to speak, over the surrounding plains," is now much less dreaded than in times past, owing to the irrigating channels which tap it, as well as to a secondary series of lateral embankments which, placed at a considerable distance from the dikes on either side, border the whole course of the river below Cremona.

FRANK D. ADAMS.

McGill University.

PROPOSED EXTENSION OF AMSTERDAM AVENUE, NEW YORK, NORTH FROM FORT GEORGE.

THE citizens of New York are justly proud of the picturesque country which forms the northern end of Manhattan Island, and of late years large sums of money have been expended in providing it with an extensive system of driveways which in their completed form will be as handsome as anything to be found in any part of the world.

The latest and most costly of these is the Harlem River Speedway, a lengthy and illustrated description of which will be found in the current issue of the SCIENTIFIC AMERICAN.

The great North and South Boulevard is the best known and the oldest of these drives. It runs from Fifty-ninth Street north to One Hundred and Eighth Street, where it merges into Eleventh Avenue, which extends to Dyckman Street. To the west and approximately parallel is the charming Riverside Drive, which, as its name implies, follows the edge of the Hudson River bluffs. This extends from Seventy-second Street to One Hundred and Twenty-ninth Street and forms the principal driveway of the Riverside Park, at the northern end of which stands the noble pile of the Grant Monument. Here the ground falls away rapidly and forms, with the opposite slope of Washington Heights, the Manhattan Valley. At this point it is proposed to bridge the valley with a steel viaduct and continue the Riverside Drive to One Hundred and Fifty-seventh Street, where it would connect with the southern terminus of the recently constructed Lafayette Boulevard, a broad driveway which follows the bluffs of the Hudson for some three miles and commands a superb outlook. At Inwood it curves to the right, following the spur of the hill, and falls with an easy grade to Dyckman Street. The southern end of Dyckman Street leads into the new Harlem River Speedway, a magnificent roadway of from 75 to 100 feet width, which follows the banks of the Harlem for a mile and a half and finally climbs on a four per cent. grade to a connection with One Hundred and Fifty-fifth Street at its junction with St. Nicholas Avenue.

If the scheme of bridging the Manhattan Valley be carried out, this would give a practically continuous drive on the banks of the Hudson and the Harlem of ten miles. The Lafayette Boulevard is practically completed and the Harlem River Speedway will be opened within a year.

Another contemplated improvement which will greatly enhance the driving facilities of the northern suburbs of Manhattan Island is the proposed extension of Amsterdam Avenue by means of a steel viaduct and arches as shown in the accompanying illustration.

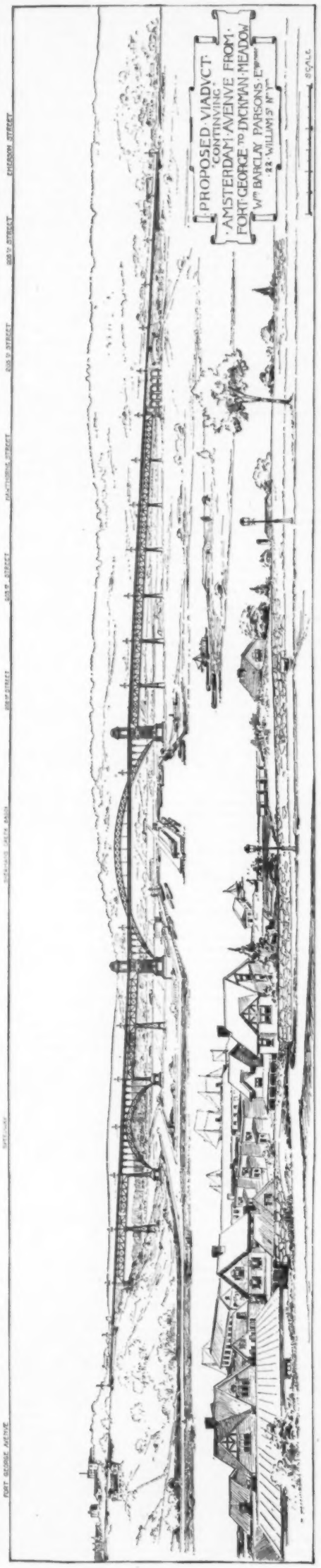
The northward extension of Amsterdam Avenue is prevented by the steep bluffs upon which historic Fort George is located. Here the ground falls away precipitously to the Harlem Speedway and the level land known as Dyckman Meadows. The proposed viaduct will fall on an even grade of 5 feet in a hundred from the cliffs at Fort George to the street grade at Emerson Street, a total distance of about 3,000 feet. The roadway will be 40 feet wide, with two outer sidewalks 10 feet wide.

By reference to the accompanying illustration it will be seen that the design of the viaduct was governed by two obstacles, each of which had to be bridged with a single clear span without any intermediate supports. The first was the Harlem Speedway and the second and main obstruction was the Sherman Creek Basin, which is being constructed by the Dock Board to accommodate vessels unloading building materials for the great building operations which are in contemplation in this part of the city and expected to take place next spring. The Sherman Creek crossing was, of course, the dominating feature of the design, and the Speedway crossing might be called a "re-echo" of the greater bridge. It must be confessed that Engineer William Barclay Parsons, who was assisted by a prominent architect, has produced a design which, whether looked at from an engineering or an architectural standpoint, is in every way admirable.

The main arch will have a span of 515 feet, or 5 feet greater than Washington Bridge arch. The roadway will be level where it crosses the arch, which it will do at about one-half its clear height of 85 feet above the water. The abutment towers, which are of exceptionally appropriate design, will be carried up on each side of the roadway and will be pierced with arches through which the sidewalks will pass. The arch will be built on what is known as the Sickle pin truss system, and the roadway will be supported from below or hung from above as shown in the engraving. This will be one of the largest arch viaducts in the world, as will be seen from the following list of existing arch viaducts:

First Douro River Viaduct	566 feet.
Garabit Viaduct	542 "
Second Douro River Viaduct	525 "
Eads St. Louis Bridge	520 "
Proposed Amsterdam Viaduct	515 "
Washington Bridge	510 "

The arch over the Harlem River Speedway is of the same type and harmonizes excellently well with the larger structure. In the design of the approaches it has been sought to make them as little like the ordinary railroad trestle as possible. To this end the legs of the piers have been brought closer together than is usual, so as to give a single column effect. This approach viaduct has been kept severely plain, with a view to emphasizing the beauty and proportions of the two large arches, and the desired effect is very happily realized.



PROPOSED EXTENSION OF AMSTERDAM AVENUE, NEW YORK, NORTHWARD FROM FORT GEORGE.

For getting rid of the floating dust issuing from the flues of briquette works, the following contrivance has been adopted in the West Kottbus district, says the Engineering and Mining Journal. In the newly erected briquette factory of the Mariannensgluck colliery, near Kausche, Germany, the speed of the air, loaded with dust, issuing from the drying apparatus, is to be reduced by passing it through roomy brick chambers, giving the dust time to settle; and with this object, for each pair of pipe drying apparatus there is a chamber between the ovens and the offtakes, so built with partitions that the steam passing from the drying ovens is made to take a zigzag course, thus depositing most of the floating dust in the lower and narrower portion of the chamber, from which it is removed at intervals and added to the undried coal.

The Bulgarian government is displaying great activity in developing the railway system of the principality, says The Engineer. The difficult and expensive operations on the Sofia-Roman section of the line are nearly completed, and the capital will then be in direct communication with Varna and Rustchuk. The remaining section from Roman to Plevna and Shumla has been contracted for, and its importance can hardly be overestimated, for it will pass through the most fertile and prosperous districts of Northern Bulgaria, where progress has hitherto been hampered by the difficulty of conveying produce to the sea or to the Danube; and the opening of the Iron Gates will also give a further impulse to the direct trade between Austria and the riverain towns of Widdin, Nicopolis and Sistovo. Harbor works at Varna and Borergas are also proceeding.

A steel boiler plate, which is claimed to be the largest one made, has been rolled recently at the Krupp Steel Works, at Essen, Germany. The plate is 39 ft. long, 11 ft. wide and 1¼ in. thick; its weight is 37,600 pounds. A plate rolled a short time ago by the Stockton Malleable Iron Company, Stockton-on-Tees, was considerably longer than this, but its area was less and its weight only 12,300 pounds.

TORPEDO BOAT DESTROYERS FUROR AND TERROR.

WE illustrate herewith the torpedo boat destroyers Furor and Terror, designed and built by Messrs. James and George Thomson, Limited, Clydebank, to the order of the Spanish government. They have now completed their trials, and have arrived in Spain. Although similar in general design to the destroyers of the British navy, there are several departures in detail, and the vessels are in some respects more nearly akin to the torpedo gunboats. For example, they are fitted with teak upper decks in addition to a complete steel deck; double awnings for the whole length of the vessel, with side curtains hanging to the water's edge, electric lighting throughout, and a number of electrical ventilating fans for insuring a supply of fresh air to the officers' and crew's quarters; so that the vessels will be much more habitable than an ordinary torpedo boat destroyer when serving in the tropical or semi-tropical climates for which they are intended. The contract provided that the mean speed should be determined by four runs on the measured mile, and by a further trial of two hours' duration, during which the speed should not be less than 28 knots. It was further stipulated that a load of 75 tons should be carried on trials, which is more than twice the load required in the case of vessels of a similar type built for the British navy.

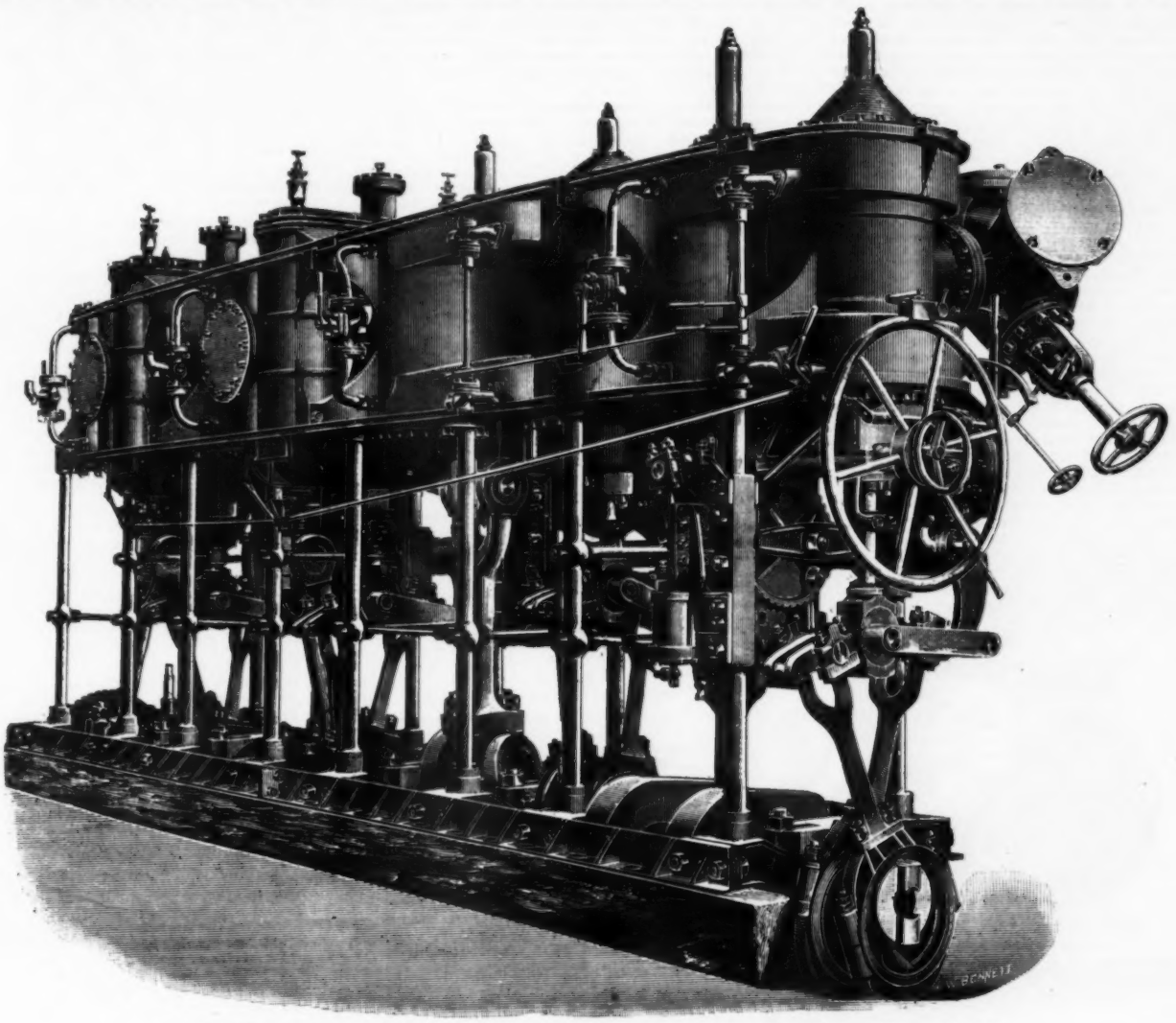
The vessels have a length of 220 ft., breadth 22 ft., and have a moulded depth of 13 ft. The loaded displacement is 380 tons. The armament consists of two 14 pounder quickfiring guns, the one mounted forward on top of the conning tower and the other aft; two 6 pounder guns of the same type mounted on the broadside, and two 37 millimeter automatic quickfiring guns, one on the starboard and the other on the port bow. All these guns have been supplied by the Maxim Nordenfeldt Guns and Ammunition Company, Limited, and are of the latest and most improved pattern. Their position in the ship is shown by the deck plans given on the present page. The vessels are also equipped with two torpedo tubes, 14 in. in diameter, mounted on the upper deck, so as to fire off either side of the ship (Fig. 3). The torpedo tubes are on the Schwartzkopff system. Four torpedoes are carried, and there is, of course, a complete installation of air compressing machinery for charging them, the engines and pumps being in the engine room.

After some preliminary trials, the Furor successfully passed her official forced draught trial on October 30. The mean speed of four runs on the measured mile exceeded the contract by about a quarter of a knot, and the revolutions were maintained without difficulty for the two hours' trial. The Terror, after a single preliminary trial, completed her natural draught trial, and, at the next succeeding trial, successfully completed her official forced draught trial. The natural draught trials were of the same duration as the forced draught trials, and it was provided by the contract that a speed of 21½ knots be maintained with the air pressure in the stokeholds not exceeding ¾ in. of water. It was found that this speed could be maintained with very great ease; indeed, the stipulated speed was exceeded by about a knot.

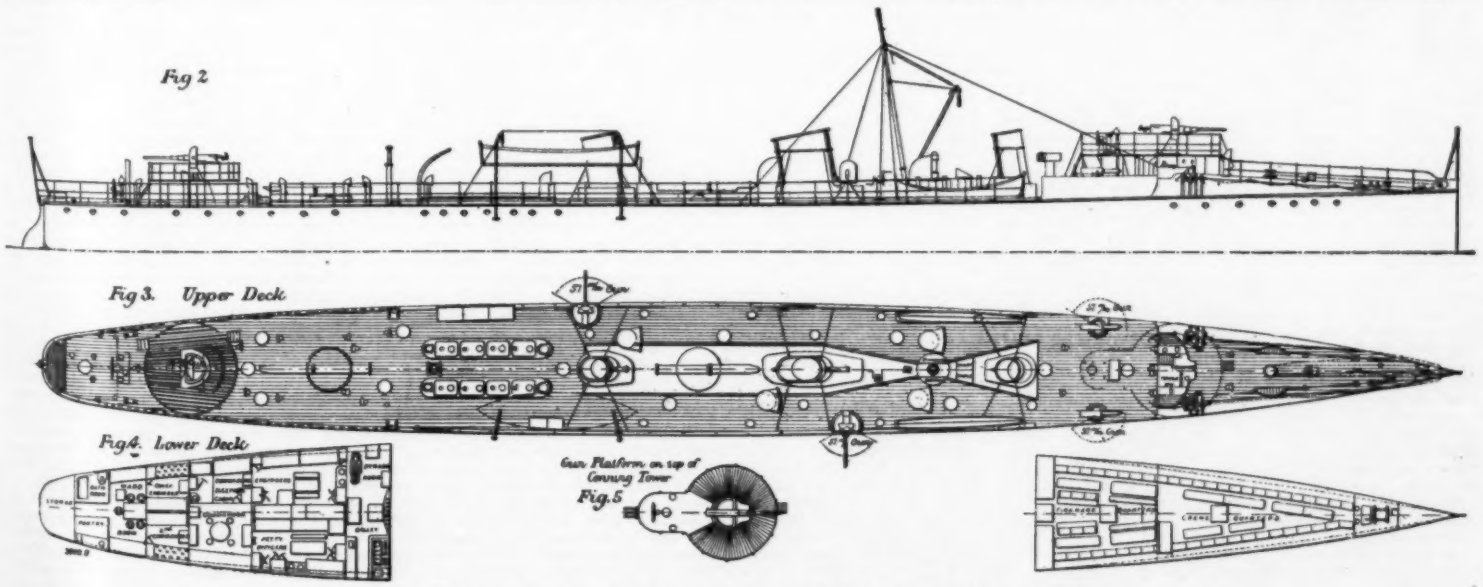
After the speed trials, the firing trials of the guns were carried out to the entire satisfaction of the inspecting officers. The terribly destructive nature of the fire, especially from the automatic guns, was very apparent, a perfect hail of projectiles of 37 millimeters or about 1½ in. in diameter being delivered by these guns, and continued so long as the person firing the gun kept his finger pressed on the trigger, the whole of the operations of loading and firing being automatically performed by the energy of the recoil.

The vessels are fitted with steam steering gear of the type usual in torpedo boat destroyers. The engine, which is of the vertical pattern, bolted to the after bulkhead in the engine room, was supplied by Messrs. Caldwell & Company, Limited, of Glasgow. The steam capstan gear is driven by a horizontal two cylinder engine, supplied by Messrs. Napier Brothers, Limited, also of Glasgow.

The vessels are propelled by twin screws, each propeller being driven by an independent set of four cylinder triple expansion engines situated in one compartment aft of the boiler rooms. Steam is supplied



ENGINES OF THE SPANISH TORPEDO BOAT DESTROYERS FUROR AND TERROR.



THE SPANISH TORPEDO BOAT DESTROYERS FUROR AND TERROR.

by four boilers of an improved Normand type, placed in two watertight compartments. These are fired from two stokeholds, the furnaces of the forward and aft boilers discharging into separate funnels, while those of the two center boilers lead up to a common central funnel of large size. The cylinders, which are entirely independent castings, are bolted together, and are stayed transversely between each other, and also to gusset plates in the wings, connecting the deck beams and the frames. A pair of struts extend from each of the high pressure cylinders to gusset plates between the deck and forward bulkhead of the engine room, and similar ties secure each of the aft low pressure cylinders to the structure of the vessel. The cylinder bottoms are separate castings, and are bolted to the cylinders, and they, together with the cylinder covers and the top and bottom covers of the valve casings, are of cast steel. The pistons are of forged steel, turned all over, and are fitted with two Perkins' metal rings. The piston and connecting rods are of wrought steel, and are hollow. The crosshead pin is fixed into the forks of the connecting rod, and is of steel, case hardened. The piston rod guide and head are forged with the rod, and the guide has machined recesses on the "ahead" side, which are filled with white metal. The "ahead" guide faces are of cast iron, with water circulation at the back, and the "astern" faces are of bronze.

The bedplates are of cast steel; each consists of two angle bar shaped castings, which extend the whole length of the engine and rest on longitudinal frames extending between the engine room bulkheads. The main bearing frames extend between, and are checked into, these castings, being secured to them, as well as to the floors of the vessel, by fitted bolts. The main bearings are eight in number, and wrought steel columns braced together near the center form the connection between the cylinders and these frames.

The crankshafts and pins are hollow, and are of steel. The high pressure and intermediate pressure cranks are arranged opposite each other, and each pair of cranks is forged in one piece. Balance weights are fitted on the crank webs, reducing the vibration to a minimum. The thrust and propeller shafts are also of steel, and are hollow. The propellers are threebladed and are of manganese bronze, each being cast in one piece.

The condensers are placed in the wings, and are of brass. The steam is condensed outside the tubes, and the water is circulated through them by a natural flow, due to the speed of the vessel through the water, two of Gwynne's pumps being fitted as auxiliaries. The air pumps are single acting, and are driven by cranks off the forward ends of the crankshafts, discharging into a common hotwell tank.

The boilers are fitted with galvanized steel tubes. They are worked under forced draught on the closed stokehold system, the air pressure being supplied by two single breasted fans in each stokehold, placed one on either side on the bunker bulkheads. The engines are of the open vertical type, and air is admitted to the fans by large cowls placed directly overhead.

The boiler feed arrangement is most complete, consisting of a main and auxilary system of feed pumps and pipes, which are separate and entirely independent of each other. The main system consists of two of Messrs. G. & J. Weir's special feed pumps, placed at the forward end of the engine room. Each draws from the hotwell tank through a Harris patent feed water filter, discharging either to the boilers in one compartment direct or through one of a couple of Messrs. Weir's feed water heaters, situated on the forward engine room bulkhead between the pumps. The feed water discharge to each boiler is controlled by a special automatic feed regulating arrangement, which keeps the water at a steady level in the boiler, greatly relieving the engineer in charge. For the auxiliary system a similar feed pump is placed in each boiler room, and each pump is connected by separate pipes with the reserve fresh water tank, the hotwell tank, and the sea, and discharges direct to the boilers. The pump in the after boiler room also discharges to the deck, and serves the purpose of a fire pump.

The main steam pipes are of galvanized steel. An independent pipe extends between each boiler room and one set of engines, and each pipe is fitted with a stop valve and steam separator on the engine room bulkhead, thereby insuring dry steam in the engine. There is also a connecting pipe between the main steam pipes and an equilibrium valve at each high pressure cylinder. An independent auxiliary steam pipe supplies all the auxiliary engines, except the main feed pumps, and the exhaust steam is led by a system of pipes to either of the main condensers.

A large evaporator is situated amidships, on the after engine room bulkhead, capable of evaporating 3,150 gallons of fresh water per day, with a distilling condenser beside it which can supply 560 gallons per day of pure aerated fresh water, chiefly used for ship purposes, the remainder of the vapor being condensed in the main condensers to serve as make up feed. A separate engine, with pumps, is also fitted for maintaining the water level in the evaporators, circulating the condensing sea water, and pumping the drinking water into the ship's tanks. An auxiliary air pump is fitted to each of the circulating pumps, and is connected to the bottom of the main condensers discharging to the hotwell tank. On the after engine room bulkhead there is also a duplex bilge pump for clearing out the bilges of the engine and boiler rooms, and ejectors have also been fitted to each compartment, so that in case of excessive flooding the water may be rapidly got rid of.

The supervision of the trials, on behalf of the Spanish government, was in charge of the Spanish naval commission, under the presidency of Commodore Camara. The constructive department of the Spanish navy was represented by Captain Talero, and there were also present Captain Peral and Captain Carlier. We are indebted to the London Engineering for the cuts and copy.

A REMARKABLE ORGAN.

A VERY curious and novel organ has been installed in the music room of the home, in Pembridge Square, London, of Mr. J. H. Van Ryn, well known in South African mining.

In this instrument are combined an orchestrion, or mechanical organ, and an organ with two manuals and a full set of pedals. The instrument can, therefore, be played mechanically or by an organist at pleasure. There are two barrels; one is for the upper, the other for the lower manual. This is the first instrument in which such a combination has been made, and the existence of the organ is due to the ingenuity of Mr. Wedlake, of Berkley Road, Regent's Park Road, a church organ builder of considerable standing.

SELF-ACTING MECHANISM DEPARTMENT.

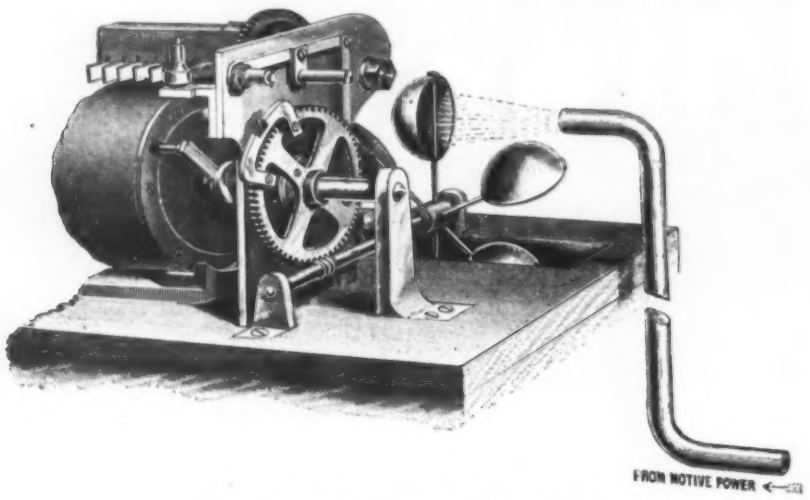
No. 1 barrel, swell organ, contains fifty-six notes and twenty keys to shift the stops. Each stop key has a locking action, which keeps the key suspended after it is raised by the staple, until such time it requires releasing, then another staple slightly higher comes in contact with the locking action and releases the key, which then falls into its normal position.

No. 2 barrel, great and pedal organs, contains fifty-six notes for the great and twelve bass notes for the pedal, and six keys for the instruments of percussion, viz.: (1) Large drum; (2) tympani and cymbals combined; (3) side drum; (4) triangle; (5) swell organ louvres; (6) tremulant.

The sound boards are made on H. Wedlake's new system of pneumatic chambers, here used for the first time. The coupling action is pneumatic, and with chambers for suboctave, octave, swell and unison couplers. By a simple device the sub and octave swell can be changed by the performer into suboctave swell to great and octave swell to great. Pedals and keys are constructed to the standard laid down by the College of Organists.

The barrel action is very simple. It is that of the well known orchestrion maker, Leopold Mukle, of Albany Street, Regent's Park. Hitherto such instruments have had to be wound up. Mr. Mukle, however, has patented the method of driving represented by the accompanying engraving. A bellows or feeder must be provided to supply wind, and a current of air from this is made to cause the rotation of a species of turbine, similar to the well known cup anemometer. The power required is very small, because friction is not set up by a long train of gearing. At Mr. Van Ryn's residence the feeders are placed in a room under the organ, and driven by water pressure from the street mains.

In this organ Mr. Wedlake has most successfully solved an exceedingly stiff mechanical problem. The organ being in any case an instrument without expression, lends itself to mechanical playing fairly well, and this instrument possesses the great advantage that the mechanical barrels do not in the least interfere with the performance of an organist. The voicing and balance of Mr. Van Ryn's organ are wonderfully good, when we consider that the apartment in which it stands contains much heavy drapery, and is devoid of pretense to acoustic properties; while the limits of space have unavoidably entailed a crowding of pipes, which all practical organ builders know is not conducive to purity of tone. It is, of course, impossible to give on paper, within reasonable limits, an adequate idea of the ingenuity displayed throughout by Mr. Wedlake in overcoming difficulties, constructional and musical. Mr. Van Ryn may be congratulated on the possession of an instrument which is, we believe, unique.—The Engineer.



WIND TURBINE FOR ORCHESTRIONS.

SELECTED FORMULÆ.

Lubricant for Wire Rope.—For the lubrication of wire ropes the use of a mixture of mica, axle grease, tar, and summer oil. According to the Engineering and Mining Journal this is unpatented, and can be made of any desired consistency. The tar and oil must be free from acid. It is claimed that it thoroughly penetrates between the wires, prevents rust, and fills the cable, resists water, does not strip, and is very economical if added sparingly, as all lubricants should be, after the first dose. It goes without saying that cables well taken care of will last very much longer than neglected ones; besides which, there is the far more important matter of safety in mine hoists to be considered, one condition of this being the clean state of the interior wire surfaces.

Lip Salve.—

Benzoated lard	8 ounces.
Spermaceti	4 "
White wax	2 "
Oil of sweet almonds	1 "
Balsam of Peru	1 drachm.
Alkanet root	2 ounces.

Digest the alkanet root, coarsely powdered, in the benzoated lard and the oil on a water bath, until a spot of mixture when cold shows a deep rose tint, then add the Peruvian balsam, strain through flannel, and melt the spermaceti and wax in the bright liquor, finally perfume with

Otto	10 minims.
Oil of ylang ylang	5 "
Terpineol	20 "

—Phar. Era.

Black Varnish.—

Shellac	8 parts.
Resin	5 "
Lampblack	1 "
Alcohol, 94 per cent	32 "

If a dead black be required, use the same proportion of ingredients with oil of turpentine as the solvent.—National Druggist.

Blackboard Lacquers.—

Shellac	250 parts.
Lampblack	25 "
Ultramarine	40 "
Rochelle salt in powder	125 "
Pumice stone	175 "
Alcohol	2,250 "

Dissolve the shellac in the alcohol, and mix in the solid ingredients.

Another good formula is as follows:

Shellac	500 parts.
Ivory black	250 "
Emery in fine powder	150 "
Ultramarine	125 "

Proceed as before.

Wood naphtha may be used in place of alcohol as a solvent, if the rooms in which the boards are placed are left open long enough for the odor to evaporate before the classes assemble.—Farben Zeitung.

Baby Dusting Powder.—

Boric acid	2½ ounces.
Starch	5 "
French chalk	3 pounds.
Oil of rose geranium	2 drachms.

—Bulletin of Pharmacy.

Prepared Table Mustard.—1. Ordinary Mustard.—Stir gradually 1 pint of good white wine into 8 ounces of ground mustard seed, and a pinch of pulverized cloves, and let the whole boil over a moderate coal fire. Then add a small lump of white sugar, and let the mixture boil up once more.

2. Pour ½ pint of boiling white vinegar over 8 ounces of ground mustard seed in an earthern pot, stir the mixture thoroughly, then add some cold vinegar, and let the pot stand overnight in a warm place. The next morning add ½ pound of sugar, ¾ drachm of pulverized cinnamon, ½ drachm of pulverized cloves, 1¼ drachms of Jamaica pepper, some cardamom, nutmeg, half the rind of a lemon, and the necessary quantity of vinegar. The mustard is now ready and is kept in pots tied up with bladder.

3. Mix 8 pounds of ground mustard seed with 1½ pints of good, cold vinegar, heat the mixture over a moderate fire for 1 hour, add 1 drachm of ground Jamaica pepper, and when cold keep it in well closed jars.

4. Frankfort Mustard.—Mix 1 pound of white mustard seed, ground, a like quantity of brown mustard seed, 8 ounces of pulverized loaf sugar, 1 ounce of pulverized cloves, 2 ounces of allspice, and compound the mixture with white wine or wine vinegar.

5. Lenormand's Mustard.—Mix with 2 pounds of ground mustard seed, ½ ounce each of fresh parsley and tarragon, both cut up fine, 1 clove of garlic also cut up very fine, and 12 salted anchovies; grind the mixture very fine, add the required mustard and 1 ounce of pulverized salt, and for further grinding dilute with water. To evaporate the water, after grinding the mustard, heat an iron rod red hot and cool it off in the mixture, and then add wine vinegar of the best quality.

6. Very Fine Table Mustard.—Digest 1¾ ounces of fresh tarragon leaves, 2 bay leaves, 1 lemon (juice and rind), ¼ drachm each of cloves and cinnamon, ¾ drachm of black pepper, ¾ ounce of dill, and 1 onion in ½ gallon of good vinegar. It is best to use a steam apparatus for the purpose. Then strain the fluid into a porcelain vessel, and, while it is yet warm, mix with it 1 pound of ground black mustard seed, a like quantity of white mustard, 1 pound of sugar, and 3½ ounces of common salt. Let the whole digest, stirring frequently, until the mustard has lost some of its sharpness by the evaporation of the ethereal oil, and then dilute, according to taste, with more or less vinegar.

7. Fresh Mustard.—The following mixture is to be mixed with good wine vinegar, or, better yet, a vinegar in which have been macerated some celery root, garlic, onion and chives: Colman's mustard, 900 parts; sugar, 100 parts; salt, 100 parts; pepper, 50 parts; cinnamon, 35 parts; cardamom, 10 parts; and ginger, 15 parts.

ENGINEERING NOTES.

The Terni Steel Works, one of the largest of their kind in Italy, have orders at present in hand sufficient to keep their armor plate department in regular operation for the next five years.

Working plans for a tunnel to connect Sicily with the mainland of Italy under the Strait of Messina are on exhibition at the University of Pavia. A tunnel is thought more feasible than a suspension bridge, as the narrowest part of the strait is two miles wide, and the least span possible, 10,500 feet, is considered dangerous on account of the prevalent high winds.

Ferro-nickel is an alloy used very much in France for electric railway rails. The alloy contains two per cent. of nickel and small amounts of manganese and titanium and is properly a kind of nickel steel. It is stated that the tread surface of the new rails is ten times as durable as that of the old ones. Also, old rails may be used in making ferro-nickel rails. — Oesterreichische Monatschrift.

The British consul at Mexico reports that on April 1 of the current year there were 6,934 miles of railway in operation throughout the republic. The increase of local traffic on most of these lines has been very encouraging, and has gone far to compensate the companies owning them for the losses which the depreciation of silver entailed on them in the payment of interest on their bonded debts.

A new departure is about to be made at the works of the Hörde Union, at Hörde, Germany, where a plant is about to be put in to utilize the waste gases from the blast furnaces for driving gas engines, which will drive dynamos, so supplying electrical energy for lighting the works and for the necessary motive power. The contract for the necessary electrical plant has been placed with Messrs. Schuckert & Company, of Nuremberg.

An old steam engine, constructed in 1745, has been used without intermission for more than one hundred and fifty years, and is still in operation for pumping water in a colliery near Bristol, England. It is used regularly five hours a day. The engine works with the low pressure of 1·3 atmospheres, its strength is 52 horse power, the connecting rod weighs 50 kilogrammes, the diameter of the cylinder is 165 centimeters and the piston stroke 180 centimeters.—Oesterreichische Monatschrift.

Her Majesty's first-class battleship Renown is to have her brass under-water fastenings replaced by fittings of aluminum copper. It is found that the brass fittings have suffered some wasting action since they have been exposed to salt water. This is probably due to the copper sheathing with which the vessel's hull is clothed setting up galvanic complications. But it would be interesting to learn the why and wherefore of aluminum copper as a substitute. Although the combination may perhaps be of inferior voltaic capabilities, there are still two metals in the question.

A steel chimney 217 ft. high has been completed at the Ridgewood pumping station in Brooklyn. The plates in the structure number 137; they vary in weight from 800 pounds to 1,400 pounds, and in thickness from ¼ in. to ½ in. The chimney measures 20 ft. 7 in. at the base and tapers to 8 ft. at the top. The braces are on the inside and consist of 205 iron rods ⅝ in. diameter and placed 12 in. apart. There is a filling in of brick for a distance of 108 ft. from the base to prevent injury from heat. The foundation is 25 ft. square. On the concrete and brick foundation rest eight octagonal granite blocks weighing 6¼ tons each, and on these is placed a circular bed plate. The furnaces of ten boilers of 250 horse power each are to be connected with the chimney.—Railroad Gazette.

Messrs. Harland & Wolff, Belfast, again occupy the premier position on the list of British shipbuilders for the past year, their total production being 81,316 tons, as against 58,093 tons in 1895, when they occupied second place. This output is the largest ever produced from any single shipbuilding yard in a year, says the Steamship. Messrs. Sir W. G. Armstrong & Company, Newcastle, are second with 54,157 tons, as compared with 30,735 tons in 1895. Messrs. Gray & Company, West Hartlepool, who last year were first on the list with 63,086 tons, occupy third place this year with 43,545 tons. Messrs. Connell & Company, Whiteinch, are fourth with 40,864 tons, as compared with 24,472 tons in 1895, and Messrs. Ropner & Son, Stockton, are fifth with 40,260 tons, as against 46,443 tons.

Though badly laid electrical wires have caused fires, and will do so again, the Electrical World, of New York, points out that where power is electrically transmitted the great risks which attend on belt transmission are obviated. What are the risks of belt transmission? In the first place, there is the risk of hot bearings. A bearing which heats will render the grease, which often thickly coats it, ready to flash into flame just as soon as the bearing attains the requisite temperature. Usually the bearing to get hot will be one close against a pulley on which a perhaps too tightly strained belt is running. The belt has an opening through which it travels from a shaft in an adjoining room. Such an opening is a ready doorway through which the flames can spread. In the earlier cotton factories it was very usual to drive a whole room of spinning frames from a line shaft in the room below. Such rooms looked exceedingly well, because they were unspoiled by the appearance of belts, but the belt ways formed flame ways, and if the lower room caught fire the upper room was sure to follow. A case is instanced by the author, Mr. Elmer, of an isolated building into which merely a belt entered by two slots in a brick wall. The shaft in this outer building ran hot, the grease on the hanger blazed up; the belt was, perhaps, fluffy, and carried fire through the slots and fired the nearest hanger. Fire ran along the dirty and fluffy shaft until the whole building was in flames and destroyed. There are two morals to this tale, and one is that belts are dangerous; the other moral is quite as clear to anyone who knows how mill gearing ought to be kept. However, Mr. Elmer points the first, and adorns the tale by recommending motors to each shaft, or better still, to each machine. Properly wire in the first place; provide each motor circuit with an efficient circuit breaker, and electric wires will be no more dangerous than so many floor girders.

ELECTRICAL NOTES.

The smallest electro-motor in the world was exhibited at Nuremberg, Germany. It is a polyphase motor weighing but 400 grammes and developing about $\frac{1}{10}$ horse power at 2,200 revolutions per minute. It was used for driving a small four bladed fan.—Oesterreichische Monatschrift fur den öffentlichen Baudienst.

An accident occurred recently on the electric railway in Berlin, Germany, due presumably to the falling of some metallic article into the conduit containing the conductors. There was a crash as a car approached, and a jet of flame five or six feet high burst from the conduit. A similar accident happened once before when a boy while playing rolled a metal hoop into the conduit. In each case the current must have been short circuited.—Oesterreichische Monatschrift.

In connection with electrical condensers, Mr. H. V. Carpenter, in connection with Mr. E. W. Poole, has been making an experimental study of the "soaking in" of a charge into solid dielectrics. Three condensers were used. In one the dielectric was mica, in the second paraffin, and the third had a very thin dielectric of a composition not ascertained. The results arrived at by the authors are that the "absorption" varies more rapidly than the thickness of the condenser, and differs with different dielectrics. The curves and results obtained are interesting, says the Electrical Engineer, but the data are hardly sufficient to warrant the setting out at greater length the conclusions arrived at upon the general question.

Speaking of a recent European visit of Prof. Trowbridge, of Harvard, the Western Electrician says: In London and Paris Prof. Trowbridge made a special examination of horseless carriages or motor cycles. He is of the opinion that the present electrical motor carriage is altogether too heavy, clumsy, noisy and expensive to be of public use. On smooth, level roads in London and Paris it seemed to run very well, but it cannot get up hills and it requires enormous power to be practical upon paved streets. An electrical carriage put on the streets of London to-day as a substitute for an omnibus would weigh about 2,500 or 3,000 pounds or more, and with passengers nearly 5,000 pounds. However, according to Prof. Trowbridge, the French intend to settle the carriage problem. They are spending a great deal of time and money in their experiments; so much, indeed, that several American manufacturers of bicycles feel obliged to be represented whenever a demonstration is made.

A curious example of the diversity of modern applications of electricity under one roof is afforded by the plant recently installed in the Central Indiana Hospital for the Insane. It is described as follows by the New York Evening Post: Apparatus of 450 horse power furnishes current for light, heat and power. There are no fewer than 3,000 incandescent and 20 arc lights, but the most interesting part of the plant lies in the laundry. A 25 horse power motor runs twelve washing machines, two sterilizing machines, four centrifugal extractors, two starching machines, one tumbling machine, a large mangle, skirt ironers and other appliances. But this is by no means all that the current does. It is led by flexible standards and wires to tables at which twelve operators work with electric sad irons. The ironing boards are arranged radially, so that the women are free to move around their work without in any way disturbing the wires or interfering with each other. As each of the sad irons is constantly kept at an even heat by the current there is no delay in changing. Only half as many operators are found necessary as when the irons were heated in the old laundry by natural gas.

Electric traction, according to Electricity, has invaded even the Paris sewers. It quotes from an unnamed contemporary as follows: "The boats are used in the larger tunnels, which are some ten feet high and eighteen feet broad, with a rectangular channel in the floor forming a canal ten feet wide and three feet six inches deep, along which the sewage flows. The smaller branches are similarly constructed, but the canal is under four feet wide, and cars with flanged wheels run on the edges of the channel, which act as rails. The primary object of both boats and cars is to drag scrapers for cleaning the channel—the admission of visitors being, as it were, an accidental adjunct. Both cars and boats are now propelled by electricity derived from accumulators contained in the leading vehicle and weighing from ten to fourteen hundred weight. In order not to unnecessarily stir up trouble—and other things—from the liquid depths, the boats have no screws or paddles, but propel themselves by picking up a chain laid along the bottom of the sewage channel and passed over a driving pulley geared on to the motor. The train consists in busy times of six boats or cars and will accommodate as many as one hundred persons."

According to the Mining and Scientific Press, as quoted in substance by the Yale Scientific Monthly (New Haven), "T. W. Young, of Washington, has invented an electrical heater to be lowered into an oil well. The idea is to generate electricity in large quantities, so that the refuse matter which clogs the pores of the oil stone will be melted and run out, causing a fresh upward flow of oil. The theory as to the exhaustion of so many wells is that the oil, in passing upward through the stone, has clogged the porous stone with paraffin in such quantities that the further flow is stopped and the well ceases to produce. Some think that it is because the supply in the earth has given out, but the generally accepted idea is that the oil is still abundant and only ceases to flow when the exit is stopped. It has been common to use torpedoes to shatter the stone at the bottom of the well, thus breaking up the clogged matter, but this is an expensive process. By the Young method, the machine, which is about three feet long and resembles an iron cartridge, is placed at the bottom of the well and electricity used of sufficient voltage to produce an enormous heat without melting the metal. The current goes down the wires, and, by the peculiar construction of the carbon-packed chambers, the intense heat is radiated into the rock in all directions, the paraffin and other refuse is softened and melted so that it runs, and when the well is started a fresh flow occurs just as strong as when it was first sunk."

MISCELLANEOUS NOTES.

The Minneapolis, St. Paul & Sault Ste. Marie Railway has tried the experiment of letting each locomotive engineer hire his own fireman, and the plan is said to have worked very well. It is now proposed to let each conductor hire his own brakeman.

There are 119,000,000 old copper pennies somewhere. Nobody knows what has become of them, except once in a while a single specimen turns up in change. A few years ago 4,500,000 bronze two cent pieces were set afloat. Three millions of these are still outstanding. Three million three cent nickel pieces are scattered over the United States, but it is very rarely that one is seen.

The capacity of the mills of the United States is estimated to be 400,000 barrels a day, or 146,000,000 barrels a year, if worked 365 days and 24 hours a day, says the Milling World. The consumption of flour amounts to about one barrel per head, or 70,000,000 barrels a year, and the exports of flour range from 12,000,000 to 16,000,000 barrels a year, making the output from 82,000,000 to 86,000,000 barrels a year.

A curious burglary took place recently at Douglas, Isle of Man. The office of the Douglas Southern Electric Tramway Company was broken into and the safe, weighing about 350 pounds, removed and thrown over the cliff. It fell about 30 ft. upon a ledge and was broken in the fall. The contents taken amounted to about $200. The safe was then pushed along the cliff and landed at last in 9 ft. of water.

After careful inquiry, it is said that the English professional man heads the list as the tallest of adult males, reaching an average height of 5 ft. 9 in. and a fraction over. The next tallest men are Americans, only a tiny fraction less tall than their English brothers. The majority of the European nations average 5 ft. 6 in. for the adult male, but the Portuguese, Austrians, and Spaniards are a little short of this.

The municipal authorities of San Francisco, Cal., have decided to erect a number of garbage crematories in that city on the Montreal system, in order to dispose of the city's refuse. In the Montreal system no fuel is employed, the garbage itself being assorted and furnishing all kindling required, as well as the fuel subsequently used. The products of the furnaces will be utilized for making bricks and also as fertilizers.

Indurated wood pulp is stated to have been adapted for the air tanks of ships' lifeboats, and tanks made of the material will shortly be in the market. These tanks are much lighter than metal ones, are extremely hard, and possess other qualities which make them highly suitable for the purpose it is proposed to put them to. Fairplay says indurated wood pulp is not only impervious to water, but has been successfully used in holding oil for lamps.

According to the latest official returns of mineral output, Spain produced in 1894 5,352,000 tons of iron ore with 12,926 miners, being an average of about 400 tons per employe; but when we come to deal with coal mining we find that to produce 1,659,000 tons of coal 15,174 miners were employed, being only a little over 100 tons per employe. In England, with the same facilities for economical mining as in Spain, the output per worker would at least be twice as much.—Science and Art of Mining.

The number of uses to which rubber can be applied is constantly on the increase, says the India Rubber World. The burnt rubber used for the final cleaning up of the gold lettering, etc., in the government printing office is simply India rubber which has been subjected to a peculiar fire process that renders it very absorbent. So remarkable are its powers of absorption that a piece the size of one's finger nail will easily take up five dollars' worth of gold in its pores. When such a piece of rubber is loaded with all the gold it will fairly carry, it is sent, in company with others in the same condition, to the mint to be assayed.

A French method of producing beautiful patterns in velvet by the removal of the pile has been successfully introduced at the works of Kussel & Cie., of Neuville-sur-Saone. Chemical means are employed, consisting of caustic soda when applied to silk or wool, or a mixture of oxalic and sulphuric acids if used for cotton. The exact quantity of each ingredient required depends on the character of the thickening used, as well as upon that of the material, these factors having necessarily a great influence upon the action. For wool and silk, 30 grammes of oxalic acid for each 100 grammes of thickening are about the average quantity, while for cotton 40 grammes of sulphuric acid for each 100 grammes of thickening are sufficient. In carrying out the process, rollers or plates cut in relief do service, by means of which the agent is applied to destroy and thus remove the pile threads, though without penetrating to the ground fabric.

Experiments made by Hempel, an expert chemist, in Dresden, throw some new and valuable light on the direct production of zinc in the blast furnace. It was supposed that metallic zinc might be separated from furnace gases, in a melted form, by subjecting the current to the action of a centrifugal machine at a temperature below the boiling point of the metal; this, however, has failed to be realized, only zinc dust and oxide being produced—other experiments also showing that the nature of the product of ordinary distillation depends not merely on the nature of the gaseous atmosphere in which the zinc vapor forms, but that the degree of dilution is also of importance. The presence of uncondensable gases in large quantity being a necessary condition of blast furnace working, the non-production of liquid zinc by the method of direct reduction is sufficiently obvious; if, however, the reduction is effected in an atmosphere containing a minimum of carbonic acid, and the gases when cooled to 60° C. are passed through a centrifugal machine, the zinc contained may be collected as dust containing from 72 to 90 per cent. of metallic zinc, silver, lead, and copper in the ore, being also volatilized as sulphides, but iron remains in the furnace. Zinc oxide, instead of being reduced only at temperatures above the boiling point of the metal, actually forms at a strong red heat.

EMPEROR MENELIK.

The Romans of Cæsar and of Tacitus went up to Gaul and Germany in days of yore in order to give lessons to mankind. Those of Humbert and Crispi, in order to receive lessons, now go down to Abyssinia. Times have indeed changed and men likewise. It is not to revert to the disaster of Adigrat that we desire to write this preamble to the history which the conqueror expects from the vanquished, and in which, under the glorious reign of Menelik I, the empire of Abyssinia will obtain the page that classifies it among the number of states that are most formidable in time of war and the least to be feared in time of peace. For the renowned descendants of Pliny and the attentive readers of Polybius, it was, indeed, a very bad thing to know this black Ethiopia standing, from the time of Solomon and the Queen of Sheba, behind its insurmountable wall of rocks, and stretching forth its African phantom arms from the blue shores of the Erythrean Sea to the pale glaciers of the Mountains of the Moon. Hercules placed his pillars very much higher. Marius, the conqueror of Jugurtha, did not even risk the flight of the invincible eagles lower than the Numidia of Bocchus. The last Augustules here possessed the audacity that was wanting in the first Cæsars; and Varus asks back again his legions from the abysses of Abba-Garima, where the modern Ethiopian, like the ancient German, does not give up the bodies of the slain. What then is this African phantom which, up to the present, has figured merely as an interrogation point in the existence of nations, and for which it was only necessary to rise yesterday, like a simoom in its deserts, in order to sweep men before it and leave blank and wide the page upon which it has been awaiting its history in peace for three thousand years? In one of my last trips to Italy, I was one day exploring the exceedingly rich archives of the Ambrogiana at Milan, when the learned librarian, Don Chierico, mysteriously beckoned me toward a glass show case, where, alongside of a beautiful blond tress of Lucretia Borgia, are preserved the most ancient and perhaps the most wonderful illustrations that an unknown illuminator of another era essayed upon a manuscript of the Iliad.

"What do you think of the writer who inspired such subjects?" asked the erudite paleographer.

"And you, what do you think of the people who served as a model for them?" asked I.

Could I imagine that, a few months later, this answer, made before a volume illustrating the acts of the Atrides and of the faithful friend of Patroclus, would find so bloody and so implacable a pertinency in the events in which a modern Agamemnon would renew the epic cycle of the Iliad with his nation of heroes?

It is because that, in the Homeric episode of a nation rising in its entirety for the defense of its liberty, and in that impregnable fortress of Harrar and of Choa, in which independence suddenly found in so-called savages its most disciplined and most heroic defenders, all is of the antique and classic levy of Greek shields celebrated by Homer. Double dealing figures there in the person of those whom history will call by name, as by name also it will do honor to those who will have done honor to the faith of treaties sworn to and violated. The intervention of a power superior to that of man, that constant jurisdiction of things that the best advised call the justice of God, will not be lacking therein. And from the first to the last bloody act that two peoples play therein, one for its glory and the other for its shame, the history of this recent war will have renewed even the touching episode of the ancient, from the somber presages of Calchas, at the beginning of the expedition, to the touching prayers of Priam, when

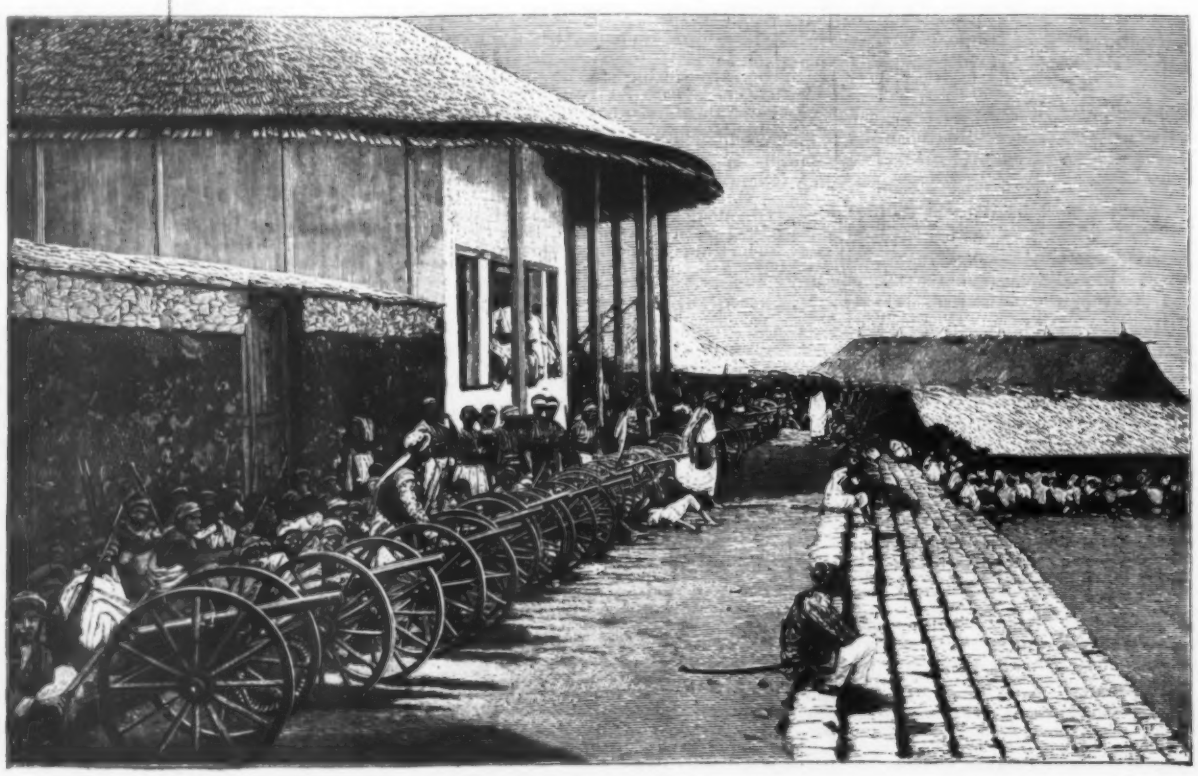
DANCE OF ABYSSINIAN PRIESTS.

conquerors and conquered will have counted their dead. Who does not remember the objurgation uselessly addressed, from the very first, to Crispi by the so-styled Old Beards of Montecitorio? and who does not recall the renewed eloquence of that supplication with which the father of Hector endeavored to soften Achilles over the body of his vanquished rival?

"All-powerful Negus Negesti, do not refuse to show thyself magnanimous to the eyes of nations," wrote to him Leo XIII. "Register this page in the annals of thy reign. What, after all, are the pitiless rights of war alongside of the rights and duties of human fraternity?"

"I was intensely moved in reading the letter of the common father of Christians," wrote Menelik to him, "and the first impulse of my heart was to give His Holiness the satisfaction that he so nobly asked of me. But, I also weep over the numerous and innocent victims of this cruel war that I have the consciousness of not having provoked."

From such expressions of barbarous souls responding



ABYSSINIAN ARTILLERY.

from such a height to the civilization that the alleged rights of war have made for us, in comparison with those chivalrous characters so nobly cast in the mould of the antique, who will be surprised that the unknown history of a savage people like this seduced one of our own people (the most obscure, perhaps, if not the most courageous) and pushed him, as the Froissard of contemporaneous chronicle, upon the roads of Ankobar and Adis-Abuba long before the hour at which the bersaglieri of Baratieri frequented it in an entirely different manner, up to the den of him who calls himself, not in vain, the lion of the tribe of Juda. A pencil for a Winchester rifle, a photographic camera for a Krupp's gun—these were his fighting weapon. It was in a trading trunk that the "spolia opima" of his pacific victory were contained. And yet did not half the baggage remain on the road?

In this journal one will find a few specimens of the treasure that Mr. George Vanderheym brought home. This bold and free explorer has already, in a small volume scarcely sufficient for the first notes of the voyage, interested us in the empire of Menelik, to which, no longer as a hasty collector of folk lore, but as a calm historian, he would like now to return. We will again give him our attention. If need be, we will aid him withour efforts by recalling to him, at the beginning of the history of "The Empire and Emperor Menelik"

EMPRESS TAI-TOU.

LE LIKE MEKOUAS ADENO, GENERAL OF ABYSSINIAN ARTILLERY.

EMPEROR MENELIK INSPECTING THE FIRST WORK IN OPENING A COAL MINE.

that he is about to undertake, that Sallust, one of the greatest historians of Rome, writing the war of Jugurtha, and not having been able to finish it, would not have desired a more glorious page and a nobler end of his career as an annalist.

At this same place, I had proposed for to-day a subject that could not have been as gratifying to me as is the opportunity of encouraging a confrere at the inception of the fine work upon which he is to engage; but the reader would perhaps have found greater attraction in the Correspondence of Menelik, the authentic materials for which are already assembled Some of these documents, which are written in the Amharic language, await their translator, who will find a more faithful courier in the next mail. He is a person who recently had charge of an official and celebrated message to Emperor Menelik himself; and it is from a letter coming from the same official source that we extract the following passage: "You would be unable to find more authentic documents as to Menelik and his court than those in the Twenty Months in Abyssinia, that Mr. G. Vanderheym has already published."

Could the author of the anticipated work expect to find a happier recommendation from so high a source? —Boyer d'Agen, in Le Monde Illustré.

ELECTRICAL WELDING.*

By SYDNEY F. WALKER.

THE subject I have to bring before you this evening is that of welding by electricity. Strictly speaking, however, as I shall explain to you in the course of my remarks, the processes that I shall describe to you are not welding at all, though they effect the junction of two pieces of metal very much in the same manner that welding does. Welding, as many of you will be aware, or the ability to be welded, is a property enjoyed only by some classes of iron and steel. In the process of mechanical welding, two pieces of the same metal whose surfaces have been prepared to unite are heated to a particular temperature, at which the metal becomes of a pasty character, and, when in that state, the junction is completed by hammering or by pressure. If the temperature of the two surfaces that are to unite is either too high or too low, the operation of welding cannot be performed. Mechanical welding also cannot be accomplished in cast iron, in copper, or in any other than the metals named above. With the electrical processes, on the other hand, junctions similar to those produced by mechanical welding can be made between any two pieces of the same metal, and by proper arrangement even between pieces of different metals. In the electrical processes the metals are raised to a temperature at which they can be worked with the hammer or other suitable means by the aid of electric currents, either passed directly through the metals to be welded, through the surfaces to be joined, or by directing the heat of the electric arc upon the bodies to be operated upon. In all electrical operations some heat waves are generated by the passage of the electric waves through any substance, however little resistance it may offer, but the art of the electrical engineer is directed to reducing all such transformations in every part of his apparatus, except where the production of heat or light waves will tend to the result he has in view. In the electric welding apparatus, where the one object is the production of heat waves at the junction of the metals he wishes to unite and their immediate neighborhood, all his calculations and arrangements are directed to deliver the whole of the electrical energy at his disposal at that spot, and to there convert it into heat energy in such a manner as to produce the result he wants—the heating of his specimens to the temperature at which they can be made to unite. He never succeeds in accomplishing this wholly. In fact, there are immense losses in the whole series of transformations—not real losses; you cannot have a loss of energy—you can only have a conversion into another form, but losses so far as the ends in view are, concerned. In order to provide electric currents for the apparatus I have to show you to-night, a long series of these transformations have to be gone through, each one entailing a loss so far as the end in view is concerned. Prof. Elliott has a boiler outside the laboratory, and Mr. Applebee has a series of boilers at the corporation electricity supply works in Eldon Road. Both are being used for the purpose of the experiments to-night. The Willans engine you see before you is driving the armature of the dynamo to which it is attached, and Mr. Applebee's engines at Eldon Road are driving armatures to which they are attached, though not quite of the same form. The revolution of the armature in each case transforms a portion of the energy imparted to it from the crank-shaft into electric waves, at the same time setting free some of the energy previously locked up in the iron forming a large part of the machines, the result being that electric currents, or, as I understand them, a series of electric waves, are passed into the cables connected to the respective dynamos. From the dynamo before you the currents are led to the switchboard, from which a portion are taken to the lamps you see around you, and are there transformed into heat and light waves, and a portion will be led presently to the apparatus on the table, where they will be also converted into heat and light waves for the purpose of the lecture. The currents generated by Mr. Applebee's dynamos are taken to his switchboard, from whence they are brought up to an apparatus, also known as a transformer, the office of which I will explain presently, from which a portion of them are brought into this laboratory to the welding apparatus you see, where a portion of them will again be converted into heat waves for the purpose already described. You will notice I have stated that at each transformation a portion only of the waves of the particular form are converted. The conversion is never complete. Each apparatus takes toll for conversion. The boiler itself and the engine both absorb heat, and not only absorb it, but pass the heat waves on to surrounding objects, as you soon discover when you stand near either of them. The dynamo demands toll of the mechanical energy delivered to it, which it converts into heat in various ways before it produces any electrical waves; the cables and switches do the same. The transformer that I referred to in connection with Mr. Applebee's currents does the same. Its office is to convert the currents, which are generated at very high pressure, at which they are generated at Canton, so that they may be delivered by comparatively small cables into currents of such a pressure that we are able to use them here without danger. These currents, as you will see, are further transformed by suitable apparatus attached to the Thomson welders before you to currents of very low tension indeed, less than that of a single Leclanché cell such as you use for ringing your bells. The object of this is to enable us to have at command in the welding apparatus the enormous currents that are necessary in this process, without the necessity of using very large cables and other apparatus. This leads me on directly to the question involved, viz., What is necessary in order to weld or unite metals by electricity? Merely bring the necessary current to the specimen, in some form or other, that will generate the necessary heat. But this is not all the problem. As you know, the temperature that a body assumes under the influence of different sources of heat varies under different conditions. All bodies absorb heat themselves, and all pass it on to other bodies near them. Further, as the air in contact with any heated body becomes also heated, expands, and moves away from the place at which it received its heat, what are termed convection currents are set up in the surrounding atmosphere. That is to say, there is a continual stream of air passing over the heated body, carrying off heat waves, and so lowering the temperature. The temperature assumed, therefore, by the body to be heated depends upon—(1) its own capacity for absorbing heat, which again depends upon its mass and its substance; (2) on the heat passing away from the body by the various paths described; and (3) the heat delivered to the body. Where electricity is the agent, the heat delivered is easily measured. It depends upon the current strength, the resistance offered, and the time; or, with a given body, the heat generated in a given time depends directly on the square of the strength of the current. It also depends, with a given body for a given time, on the square of the pressure—the E. M. F. that is causing the current to pass through the body. It is also measured by the product of the current strength and the pressure the current is working under within the body to be heated. And the power required can be measured by taking either of these quantities, which are then in the form of an electrical unit called the watt, the unit of power, and dividing them by 746, the number of watts in 1 h. p. Thus, in the Thomson welder, if a certain specimen requires, say, 15,000 amperes, at a pressure of one volt, or 15,000 watts, this is equivalent to rather over 20 h. p. If in the Benardos process a certain specimen takes 300 amperes, with a pressure of 50 volts, making again 15,000 watts, this is also the equivalent of rather over 20 h. p., though the currents are applied, as will be seen, under totally different conditions. These are not the indicated horse power in the cylinders of the steam engines. All the losses, the conversions into heat not used where it is required, have to be added, so that usually the indicated horse power is at least double the electrical energy actually transformed into heat in the metals being welded. There are three processes at present in use in this country for uniting metals by the aid of electricity, and they divide themselves into two distinct classes, very much upon the lines of the arc and incandescent systems of electric lighting.

Thomson System.—The Thomson system, the invention of Prof. Elihu Thomson, one of the able band of electrical engineers that America has produced within the last fifteen years, is on what may be termed the incandescent system. In this process the metals to be united are placed together in an apparatus specially designed for the purpose, which has been called an electric welder, and samples of which are before you. In this apparatus pairs of clamps are placed in convenient positions for holding the specimens, and on top of an iron box. Attached to and controlling the clamps are lever and screw arrangements for pressing the two metal surfaces against each other. Under the top of the box is a special form of electrical alternate current transformer, arranged to convert the current which is usually delivered to it at a voltage or pressure of 300 volts, or thereabout, down to about one volt, the result being the passage of a current of enormous strength, many thousands of amperes, through the secondary coil of the transformer and the metals that are to be united. The strength of the current passing through the metals that are being operated upon varies, of course, according to their size. The welders are made in different sizes, to take different sized specimens, and provided with transformers that will take from the primary supply circuit the necessary current required, and deliver it to the specimens converted to the proper strength and pressure for the work. Within their own limits each welder on the Thomson process is approximately self-regulating—that is to say, the current taken by the primary coil of the converter, and the current delivered by the secondary coil to the metals, is regulated automatically within the limits of each welder, by the size of the metals it is called upon to weld, very much as the current taken from the primary circuit of an alternate current electric lighting supply service is regulated by the current called for by the secondary circuits of the transformers, as lamps are turned in or out, but adjustable resistances or impedance coils are often added to give more complete control of the current. Welds have been made with the Thomson apparatus in specimens ranging from $\frac{1}{8}$ inch diameter up to 2½ inch diameter, or the equivalent in sectional area, and I see no reason that much larger specimens should not be done. The energy absorbed in the operation of welding is strictly proportional to the size of the specimens that are united under the same conditions, and omitting losses in transmitting and transforming the current. The Thomson process appears to me to be best suited for built welds, but it is also used by means of special clamps for scarf and V welds. The actual process of welding consists, with this apparatus, as you will see, in bringing the two surfaces that are to be joined into contact by means of the clamps as shown, allowing the necessary current to pass through the junction till the metals in the neighborhood of the joint are raised to the necessary heat, applying pressure by means of the levers and screws to the joint as the temperature rises, and finishing off, where necessary, by hammering, the whole process occupying from 20 seconds to 2½ minutes, according to the size of the specimens that are being worked. The Thomson patents are held in this country by the Electric Welding Company, of London, who have kindly lent the welders shown, and the specimens that will be tested after the reading of the paper. The power taken in the Thomson process for welding steel works out approximately at 22 h. p. for one minute; for one square inch sectional area welds in smaller pieces are made in less time, but with larger proportional expenditure of energy during that time; for larger pieces less power is absorbed proportionately, but for a longer time.

Dr. Zerener's System.—In the next process—that of Dr. Zerener, of Berlin—the electric arc is employed. An apparatus somewhat similar to that used for arc lamps holds two carbon pencils inclined to each other, and surmounted by an electromagnet. The arc which is found between the carbons is made very much longer than is usual in arc lamps, so that a long flame is obtained, and this flame is directed outward from the carbons by the action of the electromagnet, till it assumes a form somewhat similar to a blowpipe flame. The flame in this form is directed on the metals to be welded simply by turning the apparatus in the necessary direction. Mr. T. Scott Anderson, of Sheffield, who owns the license in this country, tells me that he uses the apparatus for all sizes of work. In particular, he has used it for welding the seams of boiler tubes up to ¼ inch thick, and for softening portions of steel armor plates, chilled by the Harvey process, that are required to be drilled. Either the continuous current or an alternating current may be employed, as convenient, and no apparatus appears to be necessary beyond the arc lamp-looking blowpipe arrangement, and the usual cables to connect with the dynamo, or transformer, and the switches and resistances for controlling the current strength. The power used in the Zerener process varies from 85 to 110 volts, and from 25 to 40 amperes, or from 4 h. p. to 6 h. p., in addition to the charges for conversion before mentioned.

Benardos Process.—In the Benardos process the electric arc is also employed, but not in the same manner as in the Zerener process. In the Benardos process an arc is formed between the metal that is to be welded and a carbon held in the hand of a workman, and provided with a suitable holder and guard as shown. A continuous current is used, which may be taken from a dynamo driven by an engine having a very heavy flywheel, or from a dynamo in conjunction with accumulators. The dynamo is allowed to run continuously, its current passing into the accumulator. The welding carbons and the work to be welded are connected to the accumulator, and draw current from it, or, if its charge is low, from the dynamo. The patents of the Benardos process are owned in this country by Messrs. Lloyd & Lloyd, of Birmingham, who have very carefully worked out the details of the invention, and who have kindly sent specimens of their work and of their apparatus. At their works they have a compound condensing engine, indicating 120 h. p., running day and night, charging a battery of 1,440 Benardos accumulators by means of three dynamos working at 150 volts. The 1,440 cells are arranged in sets of 60, all taking their charge from what are termed the omnibus bars in the switchroom, to which also all the dynamos and all the welding apparatus are connected. From the switchroom, where switches are arranged to control each circuit, and instruments to show exactly what each dynamo and each welder is doing, leads are taken to the welding room or smithy. The welding room is in appearance exactly like a smithy, except there are no fires. Each smith is provided with a mask, such as I have here, to protect his eyes and face from the glare of the arc, with a carbon holder similar to that I have, which is attached to one of the leads from the omnibus bars with a sort of anvil, to which the other lead from the omnibus bar is attached, and an adjustable resistance to vary the strength of the current and the pressure. The metals to be welded are either connected directly to the lead or are laid on the anvil. The smith, when he is ready, adjusts his mask, touches his carbon on the work to be welded and draws it gradually away, forming an arc about 2½ inches long, which creates an intense heat. As the positive pole of the accumulator or the dynamo is connected to the metal to be welded, the greatest portion of the heat is generated in the metal opposite to the carbon rod. In from a few seconds to two or three minutes the metals to be welded are at a sufficiently high temperature to be united, and are then hammered together in the usual way. Where a long weld is to be made, a short length, one or two inches, is done at each weld till the whole is complete, the time required for each heat in these cases being from 1½ to 2 minutes. Messrs. Lloyd & Lloyd are employing the Benardos process for very varied classes of work. In addition to welding pieces of metal together, they head up steel casks made for carrying petroleum, weld flanges on pipes made to withstand considerable pressure, and other things. Their plan for this class of work is to tack the two pieces of metal lightly together in any convenient manner, leaving a space that can be filled up in such a way as to unite the two. In this space are placed small billets of the same metal, the billets and the two pieces to be joined being heated to the required temperature and then hammered with a former. They also use the process for burning holes in tubes, or for burning pieces out of masses of iron, such as iron girders, the burning operation taking the place of the hammer and chisel; also for making good steel castings in which dirt has caused blowholes, etc., the flaws being burnt clean away by means of the arc, and filled in with fresh metal, so that the whole forms one homogeneous mass. In the Benardos process the power employed is from 50 to 60 volts, and from 300 to 400 amperes, or in horse power from 13 to 32 h. p., according to the work to be done, besides losses in conversion.

At the conclusion of the paper and the experiments,

The president said that they would all agree with him that the lecture had been very interesting. The present century would go down in history as the one in which the work of the electrical engineer was made practicable. The electrical welder had passed beyond the experimental stage. It was a splendid tool in the hands of the engineer, and they might say they could produce welds that would compare more than favor-

* Paper read before the Bristol Channel Center of the Institute of Marine Engineers in the Engineering Laboratory of University College, Cardiff, and published in the English Electrical Engineer.

ably with the best of welds by hand, and six to ten times more expeditiously per man, as Mr. Walker had pointed out. Yet we were quite young at this business, and nobody knew where it would stop. After all, a riveted joint was not so good as a weld, which was relatively 80 per cent., whereas these electrical welds were up to a percentage of 90. He had been struck, like Mr. Walker, with the enormous power required for electrical welding. They wanted an engine of 200 h. p., while to attempt welding with currents of 50 or 60 amperes was utterly useless. They must have 300 amperes, and perhaps 800. He believed Messrs. Lloyd & Lloyd had laid down a plant giving off something like 1,700 amperes.

Mr. Neville Applebee stated that all engineers knew the difficulty of keeping joints of steam pipes intact under high pressure—160 pounds and upward—but by electrical welding there were no joints to speak of, and all that trouble disappeared. They had seen how suitable alternating currents were for this class of work, because pressures might be increased or reduced just as they were required.

THE EARTH A GREAT MAGNET.*

THE lecture which by a usual custom is given to workingmen during the meeting of the British Association, was last year given on Saturday evening, September 19, to an immense audience in the Picton Hall, Liverpool. The lecturer was Dr. J. A. Fleming, F.R.S., Professor of Electrical Engineering in University College, London; and the subject selected by him for his discourse was "The Earth a Great Magnet."

The lecture was profusely illustrated by lantern slides and by experiments, these latter consisting mostly in projections shown on the screen by a large vertical lime light lantern.

The lecturer began by saying that his desire had been to select some subject for the lecture which should have a bearing on the trades and industry of the great city of Liverpool, and had thought that no subject within his own capacity to touch so nearly fulfilled this condition as the subject of the earth's magnetic properties and the history of the discoveries by which that supremely important invention the magnetic compass had been evolved.

The first part of the lecture consisted of a historical survey of the discovery of the magnetic properties of the loadstone or magnetite. The attractive properties in certain metals, and the fact that an elongated piece of loadstone, when floated on water, or suspended by a thread, sets itself in a certain direction, were illustrated by experiments. The earliest definite mention in English of these properties probably occurs in the writings of Alexander Neckham in 1200 A. D.; but the most important of the thirteenth century authors on this subject was Peter Peregrinus, a soldier monk serving in the army of Charles of Anjou, brother of Louis IX of France. The well known letter of Peregrinus shows him to have had a very complete general knowledge of the peculiar powers of magnetite. Experiments were then provided to show the general nature of the magnetic state capable of being produced in iron and steel, and the history of the development of the compass in the twelfth and thirteenth centuries in Europe was given. The word compass is an old English word meaning a circle. A pair of compasses is a device for describing a circle. "My green bed embroidered with a compass," is mentioned in A. D. 1415 in the will of Edward, Duke of York, and the familiar magnetic instrument takes its name from the circle of degrees added by Peregrinus and Gioja to the pivoted needle to enable it to indicate the magnetic bearing of any object. The discoveries of William Gilbert, of Colchester, then were described. Gilbert probably originally had his attention drawn to the subject in consequence of the controversies on the Copernican system, and started apparently with some idea that the earth was upheld in its orbit and caused to rotate by being magnetic. He, however, had grasped the true method of inductive reasoning from experiment. Making a loadstone ball or terrella, that is, an "earthkin," as he called it, he found a small needle poised upon it anywhere pointed to its poles. He was, therefore, led to make the grand induction that our earth itself is a great magnet, and his treatise "De Magnete," published A. D. 1600, is the thesis which supports the contention that the forces directing the compass needle emanate from the earth itself. Hartman and Norman's discovery of the "dip" of the needle in 1576 had provided a confirming fact.

One hundred years before that time Columbus on his first voyage to America had made observations which showed that the declination of the needle is different at different places, and that there is in general a variation of the needle. Columbus appears to have crossed in this voyage the line of no variation, on which the needle takes a true north and south direction.

Burroughs' exact measurement of the variation in England in 1580, however, gave a starting point for the knowledge that the declination not only varies from place to place, but varies at the same place from year to year.

The lecturer then pointed out by means of a number of charts and working models the general distribution of terrestrial magnetism. There are two poles of verticity, one in each hemisphere, where the dip needle stands vertical. These were closely attained by Sir James Ross in voyages to the Arctic region in 1831, and Antarctic regions in subsequent years. In addition to this there are in the northern hemisphere two places of maximum magnetic force called foci; and at least one and perhaps two foci in the southern hemisphere. This irregular distribution of magnetism precluded the idea that the earth acts as a single magnet. The poles of verticity do not coincide with the geometrical poles of the earth, nor do either of the foci coincide with the pole of verticity. The northern foci lie, one in the north of Canada and one in the north of Siberia. The subject of magnetic surveys was then introduced. Photographs were shown of the Kew Magnetic Observatory in Richmond Park and of the self-recording instruments therein, by which a daily automatic record is kept of the changes in the declination and magnetic force of the earth, and which are in use in many other similar establishments. A series of photographs were placed on the screen, reproducing the actual records of the Kew magnetographs. On what are called "quiet days" these traces are nearly straight or slightly wavy lines and indicate a regular diurnal change of very small amount in magnetic declination and force. But on other days the terrestrial magnetic force is found to undergo sudden irregular changes of direction and magnitude for many hours or days together, and these are called "magnetic storms." There is a certain periodicity in the occurrence and number of these magnetic storms. Curves were shown on the screen in support of the fact that years of the greatest number of magnetic storms are also in general years when the maximum number of sun spots occur, and also the maximum number of auroræ. There is a well recognized ten or eleven year period in the sun spot frequency, and this is more or less repeated in the other two physical phenomena. There appear to be periods of larger variation superimposed on this decennial one. There is, however, such a close connection that the outbreak of a large number of solar spots is always accompanied by magnetic disturbances on our globe, and by the frequent appearance of auroræ.

The question of the nature and origin of terrestrial magnetism was then considered. If the greater part of the earth's magnetism is due to the materials of which the earth is composed being permanently magnetized, then it is tolerably certain that this magnetic effect is wholly confined to a layer not much more than twelve miles thick. At that depth the rock material of the earth's crust is probably incandescent, or at least at a temperature of 800° C., and this is sufficient to destroy all magnetic quality in iron, magnetite, nickel, or other magnetic bodies. On the other hand, we know that there are electric currents circulating in the crust of the globe, and a properly arranged flow of electric currents around the globe flowing in the contrary direction to that in which the earth rotates could be made to imitate the magnetic effect of the earth. These earth currents might exist at much lower levels than that at which any permanent magnetism of the material was possible.

It has been shown by Prof. Rucher that the local deviations and surface irregularities of the terrestrial magnetic forces are consistent with the view that certain basic rocks are magnetic, and that the distribution of these underground rocks may account for a considerable part, if not all, of the irregular surface arrangement. It is possible also that an explanation of the slow secular changes in the direction and magnitude of the force at any point is due to the changes of temperature taking place in certain magnetizable rocks beneath the surface. As regards the very irregular and sudden changes which occur nearly simultaneously over the whole earth, it seems impossible to account for these except by some cosmical or outside controlling agency. It can be shown that direct solar magnetic action would not be competent to create the variations of magnetic force which occur in a storm, and some indirect action must be sought for.

The conclusion of the lecture was occupied with experiments in illustration of the inductive action of the earth as a great magnet in magnetizing vertical masses of iron and creating electric currents in moving conductors, and an ingenious piece of mechanism, a Gramme ring rotating under the influence of the earth's magnetism, which had been constructed by Mr. J. W. Swan, was exhibited. The lecturer concluded by emphasizing the enormous importance of the work that had been done in studying the behavior of the compass in iron ships, and the improvements effected in the compass chiefly in this century due to Lord Kelvin. Such a catastrophe as our globe losing its magnetic qualities could hardly be contemplated; we were, therefore, not forced to consider as a practical question whether any substitute for the compass as a direction giver could then be found.

The magnetic compass has, however, been the creator of all great maritime empires, in that these have been built up on that art of navigation in which the magnetism of the earth is a central fact.

As far as that empire which has its seat in these islands is concerned, neither its world wide commerce, nor the naval power which defends its coast, could exist for a day without the aid of the magnetic needle. Our globe spinning through space is clothed with a gossamer garment woven of lines of magnetic force, and the compass needle is as it were a sensitive finger by the help of which we feel out the path of these invisible clews, and confidently determining our direction even though wandering over wide waters, wrapped it may be in darkness or in storm, are able thereby to maintain a continual intercourse between all portions of the habitable globe.

*Abstract of a lecture delivered by J. A. Fleming, F.R.S., to the workingmen of Liverpool on the occasion of the meeting in that city of the British Association

SINGLE PHASE SELF-STARTING SYNCHRONOUS MOTORS.*

By F. H. LEONARD, Jr.

EVERY central station manager who operates an alternating plant has to grapple with the question of power distribution. Applications for power service come in from every direction, and in many cases, properly worked up, would make a more remunerative business than that of furnishing current for lighting purposes. It is perhaps unnecessary to point out that the bulk of the lighting service averages but a few hours per day, whereas the motor service covers a much longer period, with a corresponding reduction in the cost of the current output. The difference is so great that many stations are furnishing current for motor service at fifty per cent. of the price for lighting service, and, even then, figure that the motor business is the more profitable.

The drawback to the single phase synchronous motor has heretofore been that it could not be started without some other source of power, and would not carry its load up to speed. Motors are now made in which this is entirely overcome. They start up under load, and can be specially wound to give much greater torque in starting than when running in synchronism.

Two simple, well known principles are combined in this motor: The principle of the ordinary alternating current synchronous motor with that of the direct current motor or generator. The armature has two distinct windings; one a distributed winding connected to a commutator, similar to that of a direct current motor or dynamo, which in this motor is used for starting and afterward for exciting the field; the other winding is of the shuttle type, wound so as to concentrate distinct and regularly alternating poles in the armature, and performs the regular work of rotating the motor armature, advancing it from one pole to the next with each impulse of the generator.

An ordinary double throw switch on top of the motor is used in starting, there being no resistance or other complicated device, as the self-induction of the winding is sufficient to choke back any abnormal flow of current. In starting, the switch handle is depressed so that the lead wires which conduct the alternating current from the transformers are connected through the switch blades to the contacts, which lead the current first to one of the commutator brushes, thence through the distributed armature windings, and out through the opposite brushes to a coarse wire winding on the field poles and back again to the switch contacts and binding posts, these connections being identical with those of a direct current series motor. As soon as the current is turned on, the motor commences to rotate at a constantly accelerating speed until synchronism is reached, which is indicated by the lighting of a lamp located on the switch at a dull red. This is the signal for the reversal of the double throw switch, which then changes the complexion so that the leads from the transformer are cut off from the commutator and connected to the collector rings and concentrated armature windings, while at the same instant the commutator brushes are connected to the shunt field windings, magnetizing the field with direct current, the only office of the commutator after the motor is started and up to speed being to supply the small direct current necessary to magnetize the field.

In starting without load the motors will run up to synchronous speed in from five to fifteen seconds, depending upon size, windings, etc., and when loaded in from fifteen to thirty seconds, taking about the same current in either case, the time factor making the difference in the power consumed; the current taken under these conditions amounting to from twenty-five to fifty per cent. in excess of what the motor will require when running in synchronism. But when only required to start itself for light countershafting, this current may be greatly reduced by special windings.

The direct current winding delivers a perfectly smooth current and is not at all pulsating in character. In circuit with the field winding is a rheostat to control the extent of field excitation. This rheostat is located in a recess in the base of the motor, the handle for its regulation being accessible through the oval opening at the commutator and pedestal. The motor, starting switch and field rheostat are in one piece, making a most simple and compact combination. All that is necessary to install the motor is to connect the secondary wiring of the transformer to two binding posts on the motor and it is ready for operation.

The field crown is of the multipolar type, with field cores pointing inwardly; the magnetic circuit is composed of sectional sheet iron punchings, each section including two poles, stacked so as to break joints. These punchings interlock and are clamped between two cast iron rings with bolts passing through from side to side, which serve to clamp the whole together solidly, at the same time holding each punching in its proper place and tying them like links in an endless chain. The bottoms of the cast iron rings are milled to fit the base of the motor, to which they are firmly bolted.

On top of the field crown is placed a starting switch, and all the electrical connections from fields, commutator and collector brushes are brought around the outside of the field punchings to the top, concealed from view, however, by the perforated steel jacket, which is held in place by grooves in the cast iron clamping rings, forming an ornamental finish and greatly increasing the radiating surface.

As this motor runs at a constant speed it has been necessary to devise several arrangements to accomplish what might be done by variable speed motor. Motors are made for blowing church organs, in connection with which it has usually been customary to provide complicated automatic speed regulating devices. With this motor no attempt has been made to vary the speed. The organist closes his circuit and starts his motor by means of a pedal. A blower, driven by the motor, fills the bellows and maintains a constant pressure, usually about four ounces per square inch. If no air is used, the blower spills the wind out of its fan and requires only enough power to overcome the friction and maintain the pressure. As fast as the air is used the blower takes a corresponding amount of power, the motor absorbing the current accordingly.

An arrangement for elevator service which is extremely simple has been devised. The constant speed alternating motor, cable drum and gearings are all mounted on a single base casting, in which the respective parts are bolted. There is a pinion on the shaft of the motor which engages two bevel gears, each mounted on a sleeve, which also carries one part of a friction clutch, the two sleeves rotating in opposite directions, and the whole being supported by and turning freely on the worm shaft which engages the worm wheel that turns the cable drum. The other part of each clutch is keyed to the worm shaft. The controller wheel is mounted on an extension which is cast on the case that entirely incloses the bevel gears and pinion, permitting them to run constantly in oil. This controller wheel is connected to the controller cables or hand ropes which serve to operate the elevator. A pull on the hand rope turns the controller wheel, rotating it through an arc of sixty degrees. This rotation serves, first, to release the brake on the worm shaft, by means of the adjustable link and lever, by depressing the roller which travels over the cam in the controller wheel; at the same time one shipper fork is moved by the connecting rod at its upper end, which is pivoted near the upper rim of the controller wheel, far enough to cause one of its clutches to engage its other part on the sleeve attachment to the bevel gear, so as to drive the worm shaft and rotate the cable drum. At the same time the connecting rod attachment to the shipper fork opposite moves across the center of the controller wheel without producing more than enough movement to take up the lost motion in the clutch parts to which it is attached. Pulling the hand rope in the opposite direction brings

*Abstract of paper read before the National Electric Light Association, New York meeting, May, 1896.—From the Iron Age.

the parts back to their original position, disengages the clutch and sets the brake on the worm shaft. Pulling still further in this direction, the opposite connecting rod travels so as to move the shipper forks and engage its clutch, turning the hoisting drum in the opposite direction, while the first mentioned connecting rod moves across the center without causing any appreciable movement of the shipper fork. The motor runs continuously in one direction during working hours, and there is no heavy rush of current in starting, as with a direct current series motor, with its tendency to drop the brilliancy of the incandescent lights on the same circuit.

These motors are suited to any frequency in general use in this country and are wound for from 140 to 60 complete periods per second, the speed being fixed by the frequency of the generator or circuit to which it is connected.

While this motor was designed for single phase circuits, yet it is obvious that it will work quite as satisfactorily when connected to either leg of a two or three phase circuit, and where such circuits are loaded with induction motors a few synchronous motors properly distributed and somewhat overexcited would serve to allay the pernicious effects of the inherent lag or idle current which goes with induction motors, at the same time raising the e. m. f. at the extremities of the line, reducing the drop in the conductors and allowing the generators to do more work, inasmuch as they would not be required to deliver so large a wattless current.

This synchronous motor is also a good rotary transformer, and lends itself very conveniently for charging storage batteries and electrolytic work, the alternating current entering at collector rings, while direct currents are delivered from the commutator brushes. For laboratory work and as a piece of apparatus in colleges that teach electric engineering it is invaluable; for, besides the previously mentioned uses, it may be driven by direct currents as a series motor; further, it may be run at a constant speed as a direct current shunt motor, while from the collector rings alternating currents may be taken at any frequency, dependent upon the speed, which can be regulated by resistance in the field or armature circuits; or, belt driven, it may be used as a self-inciting alternator.

LINOLEUM.

By Dr. GEORGE MCGOWAN.

MANY a one has doubtless put to him or herself the question: What is linoleum, and how is it made? As this material is now so widely and universally used for household purposes, a few notes from an exhaustive article upon its history and manufacture, contributed by Mr. Walter F. Reid to the February number of the Journal of the Society of Chemical Industry, may not be without interest to many readers of Knowledge.

Although linoleum itself is quite a modern product (the first factory for it was started only thirty years ago), it has had numerous precursors, the earliest of which was waxed cloth or canvas. A varnish called "linoleon," containing linseed oil, was used in the eighth century; and in 1239—i. e., during the reign of Henry III—we find oil being employed for painting in this country. In 1636 a patent was granted for "painting with oyle cullors upon wollen cloath, kerseys, and stuffes, being pper" (?) "for hanging, and alsoe with the said cullors upon silk for windowes." Numerous mixtures of oils with resins were used until 1751, at which date mention is first made of India rubber or gum lastic as an ingredient in the coating material. In 1844 Mr. E. Galloway proposed the addition of powdered cork to plastic India rubber, in order to give a "certain elasticity" to the combination, and cloth coated upon one side with this mixture was brought into the market as a substitute for floorcloth, under the name of "kamptulicon." This latter was the immediate forerunner of our present linoleum, for which we are indebted to Mr. F. Walton. And now, at the present moment, there are twenty-five factories in operation, the greater number of them being in this country, at which 12,000,000 yards of linoleum are annually produced.

The two main ingredients in the manufacture of linoleum are cork and linseed oil, to which are added smaller quantities of kauri gum, resin, and pigments of various kinds. In the manufacture of bottle corks about one-half of the cork is wasted, and this waste is the chief source of the cork for linoleum. Mr. Reid, however, adds that in the cork forests of Algeria, etc., there is plenty of material available which, while not suitable for bottle corks, would answer admirably for linoleum. The cork waste, after being freed from dust and other admixed substances by means of a sieve with a rapid reciprocating motion, is crushed. This sounds very simple, but, as a matter of fact, the machinery required for the actual operation has to be of a very special character, both on account of the elasticity of cork and also because of the almost incredible rapidity with which it blunts the hardest steel knife edge. The breaker reduces the cork to pieces of about the size of a pea, in which state it is passed on to the grinding mill, the latter being like an ordinary flour mill, but with stones of lava, sandstone, or some other rough material. Cork dust being excessively light, it quickly disseminates itself through the air of the mill; hence the utmost precautions have to be taken to insure the protection of all artificial lights, and thus to prevent the explosive mixture of air and cork dust being set on fire. Even with every precaution, small explosions are sometimes caused by sparks from the machinery. The author says, in fact, that "speaking after considerable experience of both materials, I would rather handle dynamite in bulk than cork in a loose state." The dust has not yet been bleached successfully, i. e., the coloring matter adheres to it with such tenacity that it can only be got rid of at the cost of lessening the strength and elasticity of the cork itself. Further, although many experiments have been made with the view of replacing cork by other substances—sawdust, spent tan, peat, etc.—the resulting product possesses less elasticity than when cork is used, and so wears out more rapidly.

The next stage in the manufacture is the preparation of what is technically known as "cement," the chief ingredient of which is oxidized linseed oil. As everyone knows, oils are divisible into two classes, drying and non-drying oils, the "drying" being brought about in the case of the first named by the absorption of oxygen from the air, and the consequent transformation of the oil into a solid resinous mass. For linoleum manufacture the linseed oil used must be of good quality, and great care must be taken in its treatment. The oil is first boiled, much as in the manufacture of paints and varnishes. It has been found that the process of drying is much facilitated by the addition of a small quantity of the oxides of lead. The boiled oil, after being allowed to deposit any sediment in a settling tank, is pumped to the top of a high building, and from thence allowed to flow over a number of pieces of light cotton fabric known as "scrim," which hang vertically from iron bars. The air in the building being heated to a temperature of about 100° F., the layer of oil which adheres to the surface of the scrim becomes rapidly oxidized, or in other words, it solidifies in the course of twenty-four hours. This operation is repeated daily for six to eight weeks, until a sufficient number of solidified layers of oil are deposited on the cloth, the mass of oxidized oil having now a thickness of half an inch, and being termed a "skin." The skins are then cut down and ground between rollers. This plan of drying the oil is a slow one, but more rapid methods have apparently not been found to answer very well as yet, because there is a danger of pushing the oxidation too far, in which case the dried oil again changes into a liquid.

To prepare the linoleum "cement" itself, the ground oil is mixed with resin and kauri gum in different proportions until the whole mass is homogeneous. And here again fire has to be guarded against, as the cement has a great tendency to heat and even to inflame if left in bulk exposed to the air. The cement and cork dust are now intimately mixed together by machinery in a series of operations, various coloring matters being added at the same time, according to the color required for the finished linoleum. This linoleum mixture is then rolled on to jute canvas, to which it is made to adhere thoroughly. It should be added that, instead of jute, wire gauze embedded in India rubber is now being much used, especially for linoleum intended for staircases.

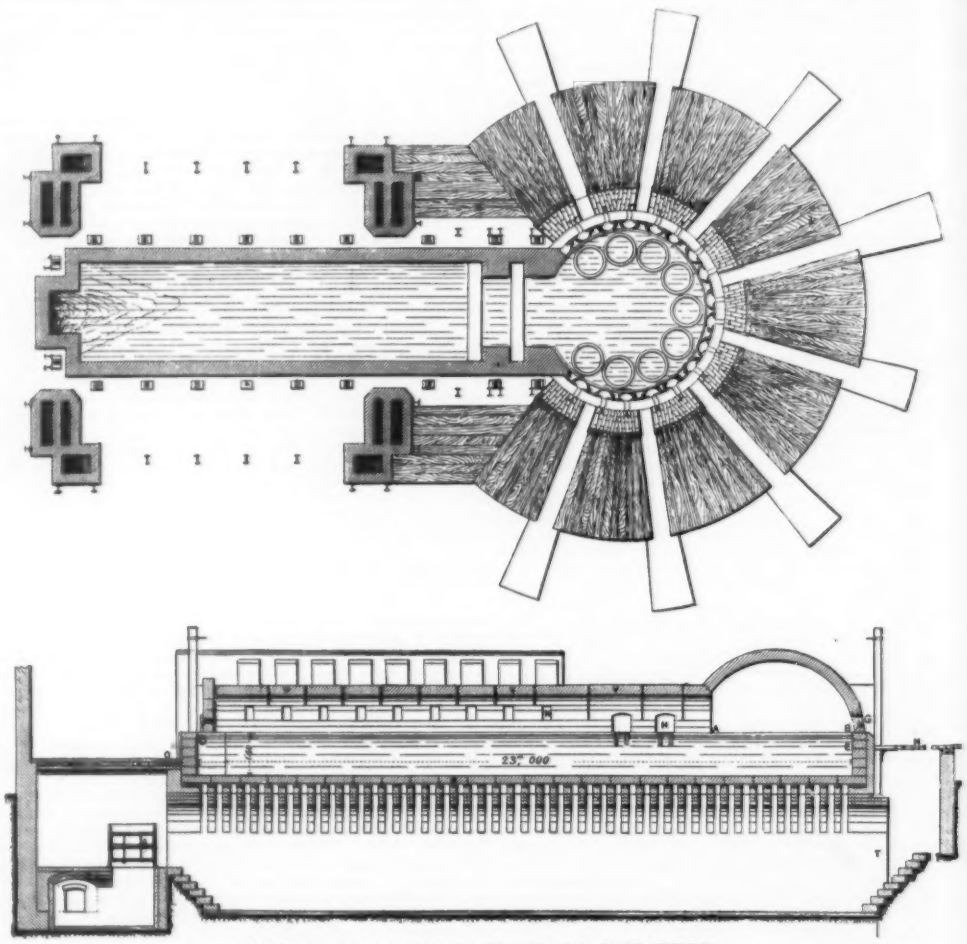
Linoleum, as prepared above, is of the same color throughout, and when an ornamental surface is required the designs are printed upon it in oil paint. This, of course, merely gives a surface coloring, which is liable to wear out, and hence various plans have been and are being tried with more or less success, whose object is to produce a mosaic linoleum colored throughout its entire thickness. But although such linoleums with inlaid color patterns have some advantages over the older kind, they have also, up to the present time of writing, certain disadvantages.

Plain linoleum is usually made in two colors, brown and red, of which the brown is the more elastic. The fact that wet linoleum is stained when any article of iron is placed upon it must often have been noticed, this being due to the tannin contained in the cork. In course of time linoleum loses its elasticity and becomes brittle, this being caused in the first instance by a change in the cement induced by further oxidation, the cork remaining unaltered. With regard to this the author of the paper remarks that a more stable cement will probably be worked out in time—possibly one derived from mineral oils, which have little or no tendency to undergo oxidation in the air. The linoleum industry, already a large one, will doubtless continue to grow, and the manufactured product itself to improve. Space will not permit of our entering into further details regarding it here, and any reader who wishes to know more about the subject is, therefore, referred to Mr. Reid's able and interesting paper.—Knowledge.

THE GOBBE GLASS TANK FURNACE.

THE furnace illustrated herewith is one of the largest examples of the open tank furnace working continuously, which has now almost entirely replaced the pot furnace in the manufacture of window glass, especially in Belgium. It is erected at the Jemappes Glass Works from the design of the inventor, M. Emille Gobbe, of Jumet, in Belgium, who has kindly furnished us with the drawings from which the illustrations are reproduced. The principal element is the melting basin or tank, which is a long rectangle, 11½ ft. broad, terminated by a circular part at the working end 18 ft. in diameter; the total length is 75½ ft., and the depth 5 ft. The bottom is formed of extra aluminous firebrick 12¾ in. thick, carried upon a double line of arches above a cooling pit running along its entire length. The sides are made in lumps of two thicknesses, the upper ones being easily removable, as they are specially subject to corrosion from floating alkaline salts at the top of the bath. As will be seen from the illustrations, the tank is kept entirely free from contact with the roof or any part of the superstructure, which is carried on independent foundations.

The vitrifiable materials, sand, lime, alkaline salts, etc., are charged at the narrow end of the tank, the fusion taking place in the section covered by the burners, K K, about 42 ft. in length, a further portion of 16 ft. being without direct heating, in which the setting or refining takes place, barriers being placed across the bath at the parts, H H, to keep back scum and undissolved materials, so that the glass may be perfectly uniform in character when it reaches the working openings, which are placed in the circular end. In the present instance, these are seventeen in number, but in some furnaces as many as thirty are used.



GOBBE GLASS TANK FURNACE, JEMAPPES.

The furnace is of the semi-regenerative type, heating being done by gas brought from producers placed considerably below the level of the furnace, burnt by air raised to a high temperature by the use of Siemens regenerators. Regenerating heating is not required for the gas, owing to the comparatively low working temperature, 1400° C. at most, as compared with 1600° or more in steel melting furnaces; but it is of extreme importance that the combustion should be maintained with great regularity, as the slightest excess of unburnt gas sets up boiling, while too much air spoils the bath by chilling, and no greater range in temperature than 50° C. is permissible. The method adopted by M. Gobbe consists in burning the gas between two layers of air, as shown in the cross section. Here the gas at producer temperature enters the furnace by the flue, and passes to the central port, while the heated air from the regenerator is introduced by the parallel flues and ports above and below it. Each of these is furnished with its own damper, so that the supply can be exactly regulated. The burners, K, are placed at the spring of the arch, which rises 5 ft. above the level of the bath to allow of the maximum development of heat by free radiation from the flame, which passes away by the ports on the opposite side through the generator to the chimney, the direction being changed by reversing valves at regular intervals in the usual way. The lower flue on either side leads to the chimney. The furnace is worked with a very slight excess pressure, only sufficient to prevent indraught of air, and the stack is therefore devoted to the service of the furnace

alone, the draught on the producers being maintained independently.

The point of principal interest in these furnaces, and that upon which their success mainly depends, is the great depth of the bath. This is due to the circumstance, first recognized on theoretical grounds by M. Gobbe, that colorless glass, when melted, is highly diathermanous, or permeable to heat radiated from luminous sources, while it is nearly opaque to obscure heat, or exactly the reverse of what happens in steel reheating or melting furnaces. If, therefore, the bath, as was the case in the earlier furnaces, is made shallow, the heat is so freely transmitted downward, the bottom may be rapidly corroded and penetrated; or even if the latter accident be avoided, the glass is likely to be deteriorated by alumina dissolved from the bricks. This trouble has been overcome by the bold expedient of increasing the depth of the tank to 6 ft. or 7 ft., so as to provide a sufficient amount of heat-intercepting material. As a consequence, the furnaces are of enormous capacity, a single tank may contain up to 400 tons of molten glass, which sufficiently explains the reason why extreme care must be taken in providing proper foundations. In bottle glass furnaces, where the "metal" is dark colored, owing to the presence of ferrous oxide, the tank may be much shallower, a depth of 33 in. being sufficient to allow a protecting layer of unmelted material of about 8 in. to form at the bottom.

We are indebted to the London Engineer for the cuts and information.

THE BOG SLIDE OF KNOCKNAGEEHA IN THE COUNTY OF KERRY.*

AT about three a. m. on Monday, December 28, 1896, a catastrophe occurred some twelve miles northeast of Killarney, of which mention has been already made in these columns (January 23, p. 58). A bog gave way at its lower edge, and precipitated itself as a black, peaty flood into the valley of the Ownacree River. In the upper part of its course it unfortunately overwhelmed the cottage of Cornelius Donnelly, carrying away the structure and its eight occupants. Five of the bodies were recovered, with considerable difficulty, by January 3, when the mass had come practically to a standstill. In the lower part of its course, it flooded a number of farm lands upon the slopes of the valley, and seriously threatened the cottage of Jeremiah Lyne, rising some five feet against its wall. Even at the junction of the Ownacree and the Flesk, one of the great feeders of the Lower Lake of Killarney, the banks were smeared over with a peaty mud, ten miles from the point of origin of the bog slide; while a quantity of the material was carried another nine miles west to the Lower Lake itself.

While the first accounts of the disaster were naturally exaggerated, and even contradictory, coming as they did from places on opposite sides of the peaty watershed, an inspection of the area leaves no doubt as to the magnitude of the bog slide. Such phenomena are not unknown in Ireland, one being recorded from the County of Galway in 1745, and another having been reported on by Sir R. Griffith in 1821 ("Report Relative to the Moving Bog of Kilmaleady in the King's County," Journ. Roy. Dublin Soc., vol. i). In the latter case, 150 acres became covered with the products to a depth of eight to ten feet, and the flow extended from the edge of the bog one and a half miles down a valley. Probably in all cases such flows are merely a rapid extension of those "creeping" processes which produce rifts and areas of subsidence in bogs formed upon a slope.

The scene of the present bog slide lies among carboniferous rocks, and is included in sheet 174 of the 1 inch ordnance map of Ireland. A perfectly straight road runs N. N. W. from Shinnagh House, which is near the railway; at the cottages of Lisheen a branch runs west, meeting four other roads in the grass-grown quarries of Carraundulkeen. (I use the spelling of the ordnance survey throughout.) The bog in which the slip occurred lies between the road from Lisheen and that running almost north from the quarries, which is locally known as the Kingwilliamstown road. It is a brown almost level upland, a mile across, mainly in the townland of Knocknageeha, and is bounded on the north and south by inclosed and cultivated hills, which rise from 780 feet to 847 feet above the sea. The highest point recorded in the bog is 776 feet, and there is a fall of 1 in 38 between this and the bridge between the quarries. The streams on this side flow to the west coast, while the east side of the bog drains direct into the Blackwater.

Several deep peat cuts existed in the bog, perpendicular to the direction of its subsequent flow, and these have the appearance of rifts or "faults" at a distance. But the lost portion seems to have oozed out from below a large area of the superficial peat, lowering the surface into a series of hummocky and very irregular steps. At the same time, great masses of the surface, with tufts of grass adhering to them, were floated down and hurried into the valley, looking, as one man told me, "as large as houses."

The flow appears to have been rapid and silent, though the noise of the storm which raged through Sunday night kept many of the cottagers awake. Even within a few hundred yards of Donnelly's house, no suspicion of the fate of the unhappy family was raised, until dawn revealed the black flood tossing, and still hurrying down the valley. A young peasant, living close to the edge of the flow, told me that he was roused only by the bellowing of his cow; in another case, a man went at about four a. m. to a point three miles down the valley to remove two calves, which he intended to drive into Killarney. He was then almost overtaken by the rise of the peat flood at Annagh Bridge. I conclude, therefore, that no unusual sound or movement of the earth occurred, such as might have warned him of the coming danger.

The full flood first attacked the Kingwilliamstown road, on the east side of which the bog abutted. It filled up the hollow, climbed the embankment, and fell over the western side like a very fluid lava flow. The guiding line here was the course of the streamlet that drained the bog into the Ownacree River. Probably the road itself has been carried away beneath the thick mass now covering its site, and communication with the north is likely to remain cut off for some weeks. On January 3, movement had ceased at this point, but the embankment on which the road runs alone prevented a further downrush.

Donnelly's cottage stood on the west side of this road, and was totally swept away. Its thatched roof was seen floating for a time, but the house is said to have been built of loose stones, and rapidly succumbed. The bodies recovered were found at various points in the first four miles of the flow.

The Royal Dublin Society have appointed a commission, consisting of Prof. Sollas, F.R.S., and Messrs. De Lap, A. F. Dixon, and R. Lloyd Praeger, who may be trusted to give us an accurate survey of the flow; the present paper will therefore be concerned with its broader geological aspects. Viewed from any of the neighboring spurs, the valley of the Ownacree (the "Quagmire River" of the ordnance survey) now seems occupied by a black flood winding with the course of the original stream. Here and there lakelike expansions occur, with pools of water on their surface; and, lower down the valley, the stream asserts itself, and is now cutting out a channel through the débris, or, rather, is washing out its original course. Without an intimate acquaintance with the country, it is difficult to know what changes have occurred in the form of the true valley floor; but the local constabulary assert (Freeman's Journal, January 2, 1897) that a considerable deepening of the valley has resulted in places from the scouring action of the flow. This obviously applies only to the first two miles or so below the quarries, where the stream originally ran over a flank of the great Annagh bog. At and below Annagh Bridge no trace of any deepening is to be seen; the torrent is merely washing its way clean again, and revealing the original bowlders on its floor.

To return to details, the passage of the flow across the western road, between Quarry Lodge and the older quarries, resulted in the filling up of a limestone quarry and the destruction of the embankment of the road, together with its double hedges. Judging by the state of things at Annagh Bridge, the upper bridge may perhaps be found also standing, when the peat flood can be cleared away. The destruction here is, however, considerable, and the oozing of the material through the hedges reminds one of the behavior of some of the thin lava sheets of Hawaii. Great stems and roots of timber, formerly buried in the upper bog, have been floated down, and stick up fantastically, like arms waving from the flood.

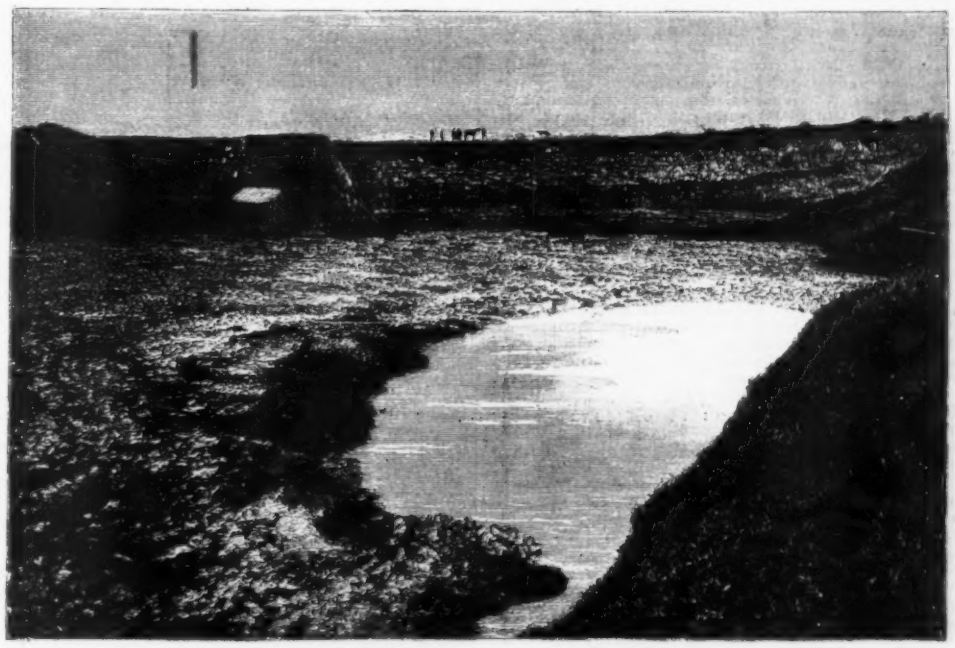
The main road to Killarney is thus effectually breached; and a still more striking scene occurs on the parallel road at Annagh Bridge. Here the floor of the valley was flat for nearly half a mile west of the bridge, and was divided into a number of fields. The peat has covered the whole of these, and climbed, as has been said, against the wall of Lyne's cottage. The road is broken into sections and seems utterly destroyed; and bog timber, which is abundant in this district, juts out everywhere above the slime. The peat has left traces on the top of the buttresses of the bridge, six feet above the present level of the water; and movements were noticed here in the subsiding flow a week after the catastrophe.

After this wild scene, the valley narrows, and the black borders to the stream show the height to which the flood first rose; every bowlder has a bank of débris behind it, and islets of peat, bog timber, and grassy tussocks have risen in the middle of the stream. The piers of Six Mile Bridge, close to Barraduff, six miles from the original bog, are still clogged with timber, and show peat patches a good five feet above the stream. Even travelers by rail can trace from this point downward the black deposits on the banks of the Ownacree, down to the viaduct before Headford Junction.

As to the origin of the bog slide, it must be compared, as already hinted, with the phenomena of surface creep, which are strikingly illustrated by the stone rivers of the Falkland Isles and the constantly occurring landslides of the taluses of Tyrol. The ridging of soils upon steep hillsides is a well known and milder form of this sliding motion; and a field laid out upon a slope, in an even moderately rainy climate, may be considered as being always added to at the upper end, and carried away down hill at the lower. In peat bogs, the water finds its way out in numerous channels into the main stream of some neighboring valley; and the banks of these channels are always in a state of flux. During stormy weather, the black saturated lower layers of the bog are washed out in far larger quantity than the brown and drier upper layers. Rifts and signs of movement in the latter will then readily occur.

As Sir R. Griffith pointed out in 1821, there is little cohesion between the water-logged lower layers and the impermeable clay or other material which underlies the whole, and which allows, in the first instance, of the accumulation of the bog. The moving bog in the King's County was accounted for by the occurrence of a dry season, during which extraordinary cuttings were made, giving a face of thirty feet. The pulpy

SCENE NEAR QUARRY LODGE, WHERE A HOUSE AND FAMILY WERE SWALLOWED UP.



THE LIMESTONE QUARRY FILLED WITH BOG.

THE SLIDING BOG IN COUNTY KERRY.—FROM PHOTOGRAPHS BY TIMOTHY HEALY, KILLARNEY.

* For our engravings we are indebted to the London Graphic.

lower layers were thus reached, and were set free, carrying away the upper masses on their surface. The process is analogous to that which forms caverns in many lava flows, the fluid lower portion becoming liberated and rushing out from under the upper part.

Similarly, the deep cutting of the bog of Knocknageeha may have been injudicious in so wet an area. It is possible that official inspection is required in these matters, as in more elaborate quarrying operations; and the loss of life in the present instance makes a consideration of the condition of other bogs at least desirable. But the immediate cause of the flow seems to have been the heavy rainfall of December, 1896, which raised the level of the water in the workings and the level of saturation in the bog. Even in broad daylight it would have been impossible to check the movement, when once the Kingwilliamstown road had been overpowered. The slope on which the bog moved, making in the first mile an approximate allowance for the original thickness of the peat in Knocknageeha, falls about 120 feet in the first mile, 100 feet in the second, 95 feet in the third, and 45 feet in the fourth. The fall of the valley floor as far as Annagh Bridge is thus about one hundred feet per mile, decreasing rapidly before the bridge; and it may be remembered, for future guidance, that this fall is sufficient to allow of a bog slide of truly catastrophic character.—Grenville A. J. Cole, in Nature.

THE NEW MANUAL OF BOTANY.*

IT is with a sense of consternation, a hearty shock of surprise and bewilderment, that a botanist who has formed his associations with plants under the guidance of Gray's Manual will turn over the pages of this remarkable and impressive work. He might at first experience a dim impression of unconsciousness as in the approach of vertigo, fixed objects begin to swim before the eyes, and the assured relations of familiar things have become vague and indeterminate.

This work is the last expression of a radical school of botanical terminologists and has expanded on the logical principle of priority in specific names, and embodies the philosophy of evolution. One is constrained to be patient because of its immensity, its painstaking elaboration, and the self-denying labor and expenditure it represents. Admiration is also challenged, and if there must be a surrender of time honored and deeply engraved memories, the captive can at least boast of changing his allegiance to a noble and distinguished captor.

Indeed, if the part of the revolutionists must be taken, it can be urged in behalf of the extreme severity of their innovations that so far as it embodies the best sense and the best science of the subject its very radicalism gives to it definition for the student, and frees its outlines, its principles, and its results from any blurring confusion with the outlines, principles, and results of a discarded and discredited system. It is given a sharp focus, and the depth of its severance from a preceding method will instinctively reveal the new tendencies, and, possibly, the new knowledge it represents.

Prof. N. L. Britton and Judge Addison Brown, at the outset, to overthrow the obstacles in the path of their scheme of reconstruction, have summoned the artist to their assistance, and by drawings, partly anatomical and partly illustrative of every species of plant, have driven straight to the heart of their problem. They have enormously simplified, to the collector, the task of identification. This cannot fail to insure its method, even its vagaries, wide attention, and even acceptance, and few who shall have their labors of determination lightened by these figures will be inclined to desert a guide so helpful, no matter how far its nomenclature departs from older standards.

If we open Gray's Manual, we find the De Candollean and Bentham series, beginning with the Crowfoot family, followed by the barberries, water lilies, mustard, pink, pulse, rose, saxifrage, parsley, honeysuckle, to the composites, through the heaths and monopetalous groups, to the apetalous, and thence through the endogenous plants to the cryptogams. Now there is at places in this system an appearance of arbitrariness that makes one doubt if De Candolle did not himself yield to artificial considerations, much as he repudiated the more purely provisional devices of Linnæus. The introduction of the water lilies and pitcher plants between the barberries and poppies, the position of the Compositæ in the middle of the series, with the oaks and pines separating the orchids and lilies from the other herbaceous plants, seem incongruous.

But we are to recall the fact that the ideas of evolution were not at all involved in this scheme. It was not meant to throw any light upon the age of different families or the relative time of their introduction in the world. It had no chronological meaning. It did have a morphological significance. It was meant, as far as its authors understood it, to give their views as to the existing relations of plants from morphology. If embodying an intelligible structural relationship—a relationship determined by or having reference to their formative elements—it might seem preferable, at this stage of the world's knowledge, to a system which is evolutional in design, but speculative in fact.

Its scheme in its main outlines is supremely reasonable as a comprehensible arrangement of plants. In the words of Dr. Gray in his fifth edition, "beginning with the highest class and ending with the lowest; and commencing this first and far the largest class (of Dicotyledonous or exogenous plants) with those orders in which the flowers are mostly provided with double floral envelopes, viz., with both calyx and corolla, and in which the corolla consists of separate petals (the Polypetalous division); beginning this series with those orders in which the several organs of the flower are most distinct and separate (hypogynous), and proceeding to those which have the parts most combined among themselves and consolidated with each other (perigynous and epigynous); then follow those with the petals combined into a monopetalous corolla (the Monopetalous division); and, finally, those destitute of a corolla or destitute of all floral envelopes (the Apetalous division). The class of Monocotyledonous or endogenous plants opens with orders exhibiting one form of simplified flowers, passes to those with the organs most combined and consolidated, then to those less combined by aduation of parts, and closes with other simplified and reduced forms."

In 1883, the last volume of the "Genera Plantarum," of Messrs. Bentham & Hooker, was published, and after an exhaustive study, supplemented by almost inexhaustible material, these two botanists, of unrivaled intellectual acumen and the most extended technical culture, agreed to maintain in its principal features the arrangement of the natural orders established by the elder De Candolle; and, remarking this, Dr. E. Corson observed, in his review of this monumental work, "it is a fortunate circumstance that the authors of the 'Genera' have added the weight of their authority to the judgment of those botanists who hold that no one of the various arrangements which have been proposed during the last half century, and more or less extensively adopted in some parts of Europe, possesses advantages which can compensate the serious practical inconvenience of having systematic works of reference arranged after a variety of discordant systems."

Whether we begin with cryptogams or end with them for purposes of classification is of no consequence; their positively inferior position is recognized, and no one is likely to misunderstand their lowliness of organization. But science is restless and knowledge is progressive. The relationship between many of the natural families was unknown; as Gray remarked, they were often arranged in deference to convenience rather than phylogeny, and some rearrangement was inevitable. The contention made is this, that manuals as authoritative standards should not be made the vehicles of theory; they should not lend their immense influence to what may prove to be provisional positions. It would seem likely that this new manual may be regarded as meriting such an impeachment. With this deprecation let us look more closely at the pages of this epoch-making work.

The Illustrated Flora begins with the cryptogamous or flowerless plants, here designated as Pteridophyta. The old arrangement of the families is considerably displaced, and some new families created, as the Selaginellaceæ and Isœtaceæ, a favorite fancy of the Germans, and the Gymnosperms follow, in deference, we suppose, to the connection pointed out by Hofmeister, Millardet and Pfeffer between the Cryptogams and the Coniferæ, which might, however, be overruled by the exogenous growth of the latter and their polycotyledonous seed. The Gymnosperms may be a connecting link between the Cryptogams and the Angiosperms, but is it proved?

Turning to the pine family, some familiar names are found changed, but the impression made by the descriptions is certainly one of great pleasure. The text is almost copious, and details are supplied which were never suggested in the old manuals, while the figures are clear and adequate. There is no escape, at this point, from almost a willing capitulation to these beneficent instructors.

The Angiosperms follow, and the groups of the Monocotyledons and Dicotyledons is naturally maintained. The Monocotyledons are first treated, and the families suffer considerable disarrangement, the merit of which can unaffectedly be left to the specialists, though the sympathetic observer will feel inclined to question the need or the justice of some changes. Looking over the Orchidaceæ, it is not invidious to say that the definition of that family poorly compares with Dr. Gray's capital analysis. It has not the verbal felicity nor does it define so lucidly. It seems too stiltedly technical, dry and uninteresting. Such a criticism may evoke a smile from the herbalists, but this book must bend, we opine, to the genial tastes of the fastidious collector, as well as meet the needs of the saturnine systematist. The Orchidaceæ was prepared by the late Rev. T. Morong. The usual surprises prevail. Gyrostachys takes the place of Spiranthes, Peramium for Goodyera, Achroanthes for Microstylis, Leptarchis for Liparis, Limodorum for Calopogon.

This brings prominently in view the more unlovely side of this work. In genera and species the law of priority is remorselessly applied. The editors, in this regard, display an almost Machiavellian ingenuity and an insensibility that reflects upon their claims to human consideration. Names dignified by the use of half a century are consigned to oblivion because a microscopic search of literary remains proves their secondary origin. The exploration that this ruthless hunt for priority must have necessitated fills the reader with amazement, but it is an amazement unconsoled by any sympathy in the purposes of the explorers. Up and down, this way and that way, high and low, the octopian and briarean tentacles of their investigation have elongated their insidious filaments and brought to light new names, and they have exultingly advanced them into the honored seats of long respected appellations.

The confusion reaches the limit of sanity when specific names long associated with one species are put upon a different species, to the utter confusion of the identity of both. This reaches its most vexatious extreme in the hickory nuts. To begin with, Nuttall's genus Carya is replaced by the barbaric, if indigenous, Hicoria, and then a tempest of misrule is let loose. The pecan (Carya olivæformis) becomes Hicoria Pecan, C. alba is H. ovata, C. sulcata is H. laciniosa, C. tomentosa is H. alba, C. microcarpa is spared, C. porcina is H. glabra, and C. amara is H. minima. Carthago delenda est indeed.

But we must pause. These complaints seem almost to our own ears querulous, when, turning over the pages, the delighted eye meets the excellent figures of which one most important feature is the enlarged morphological elements.

Every species is illustrated, and the magnitude of this effort may be appreciated when we find all the grasses, sedges and rushes treated with the same care and thoroughness as the lilies and iris.

No pain has been spared to help the student. Artificial keys prefix the larger families, and the descriptions are lengthy. The extreme verbal picturesqueness of much of Dr. Gray's diagnosis seems lost in these descriptions, but their merit is unmistakable. Dr. Britton and Judge Brown in special groups have received assistance, but their individual labor must have been incessant and endless.

The American botanists are to be congratulated upon the publication of so great a work, in paper and typography faultless; but with such jubilation as it will raise, there will be mingled a few sighs that it seems to mask and push to one side the more luminous phraseology of Dr. Gray's manual, no less than a terminology imprinted in literature and art. L. P. GRATACAP.

* An Illustrated Flora of the Northern States and Canada, westward to the 103d Meridian, including Kansas and Nebraska. By Prof. N. L. Britton and Hon. Addison Brown. 1896.

THE ANNUAL ADDRESS TO THE ACADEMIE DES SCIENCES.*

GENTLEMEN: The disinterested study of Nature's great phenomena is often rewarded by important results in directions totally different to those anticipated by the public, and sometimes also different to those the investigators themselves had originally in view. When Volta, Ampere and Faraday generated electricity and studied its effects on a small scale, what rare genius could have imagined that their discoveries would change the appearance of the world, would modify its social conditions, and create wealth in barren regions? When Lavoisier, Schwann and Cagniard-Latour studied the fermentation of beer, and when Pasteur, taking up the question, patiently observed the development of those microscopic beings said to be spontaneously generated in the case of maladies affecting vines or silkworms, who could have anticipated that the day would come when this wonderful chain of research would be of interest to the whole of humanity, and that it would be proved that these infinitely small beings are one of the most formidable enemies to human life? Yet this is the conclusion drawn from these researches. Pasteur has in fact taught us during his long and fruitful career that it is possible to classify these organisms, to fight them, and even to direct them, for, according as they are our allies or enemies, they can confer certain immunity or death.

The public only sees the final success; it is generally ignorant of the oft mysterious starting point of these researches, and it does not realize the labors and the perseverance that have been required to arrive at what is popularly called a practical discovery. The world is inclined to decry abstract science, the source of all thought, and to measure the merit of the savant by the immediate utility—that is to say, by the commercial value—of his discoveries. Utilitarianism is, in fact, one of the most serious maladies of existing society, for it tends to prevent the human mind from soaring after the ideal, and to confine it exclusively to the worship of material interest. The history of the great discoveries of the century, the fruit of long and disinterested study, shows, however, that the cause of actual progress is not so much the development of the results obtained, as free, abstract, and even fanciful research; in short, the source is pure and independent science, a willingness to be led by every inspiration of the intellect.

X RAYS.

The past year affords a striking example of these unexpected fruits, the outcome of the accumulated efforts of several generations of natural philosophers, whose starting point was modest enough, but whose final results have assumed exceptional importance. I refer to the discovery of Prof. Roentgen, of which I, as a physicist, feel bound to speak to-day; for these famous X rays have been to the public, as well as to savants, the scientific event of the year. I will relate their history—an instructive one.

To find the first germ we must go back to the middle of the last century. At that period electrical phenomena excited strong interest; the bold comparison of laboratory experiments with the grandiose manifestations in the clouds, the explanation of thunder and lightning, the invention of the lightning conductor by Franklin, had fired the imagination and spread a taste for electrical experiments. Physics had become a fashionable amusement. People of quality did not disdain to attend the lectures of Abbe Nollet, instructor of physics to the Dauphin, and to follow the demonstrations which the expert experimenter reproduced before their own eyes. Some of the engravings of that time give us glimpses of these gatherings. We see the spruce and coquettish abbes of the court, elegant cavaliers and ladies in grande toilette, crowding round strange looking apparatus, and amusing themselves by drawing sparks from the electrical machine or by producing brilliant brush discharges. The experiment of the brush discharge in vacuo was one of the most remarkable because of its scale and splendor. This brilliant effect was obtained in the "electric egg," a transparent glass globe with two metal rods terminating in knobs, between which the electric discharge took place. The spark was first zigzag, like a lightning flash, then spreading out more and more as the vacuum improved, and, finally, when viewed in the dark, filling the entire globe with a magnificent rose colored or purple glow. Such was the simple and charming experiment which, after having entertained the dilettanti of physics, has now led to those famous rays which are endowed with such curious properties. But the way was a long one.

For nearly a century nothing new was added to our knowledge of this brilliant phenomenon. It was not until 1843 that Abria, of Bordeaux, while making researches in induction, tried to pass the induced discharge across the "electric egg." He found that at a certain exhaustion the beautiful violet glow, diffused all over the interior of the globe, become stratified; that is to say, divided alternately into bright and dark strata. Furthermore, the positive knob always gave a brush discharge, while the negative knob was surrounded by a dark space. It is this dark space which played an important part later. After Abria, the stratified discharge, excited with more powerful electrical apparatus, was studied in England and Germany by Gassiot, Warren de la Rue, Spottiswoode, Hittorf and Crookes, and the shape of the bulb became definitely that of an elongated hour glass, furnished with two electrodes, which replaced the two rods of the "electric egg." Regular stratification becomes apparent at the degree of vacuum cited by Abria, and with the same characteristics, viz., a brush discharge at the positive electrode, and a black sheath round the negative electrode or cathode.

Needless to say, these experiments were not, as in the last century, simple amusements meant to please the eye. It was hoped by their means to discover the

* Delivered by M. Cornu, December 21, 1896.—Abstract from the London Electrician.

mechanism of the discharge, that is to say, to solve the great problem of the propagation of electricity. But in this respect our hopes were disappointed, and there was a risk that all research in this direction would be abandoned, when Prof. Crookes, guided by theoretical views as to the state of matter in rarefied gases, investigated the behavior of the electric discharge on continuing the rarefaction of the gas in the tube to an extreme degree. He then observed a series of new phenomena. As the vacuum improved, the dark space round the cathode increased in size, driving the stratifications before it, until they vanished one after the other. Finally, the dark space filled the whole tube; the glass of the tube began to fluoresce, especially the part opposite to the cathode. Prof. Crookes saw in this phenomenon the confirmation of his views. He held that it was the molecules of the rarefied gas, repelled by the negative electricity, which bombarded the side of the tube, and that their impact occasioned the glow. He then performed a series of most curious experiments to prove the existence of these projectiles. In one tube he stopped them by means of an internal aluminum screen, and the shadow of the screen was depicted on the end of the tube. In another case he used their impact to turn a little mill. Finally, in a special arrangement, which was afterward termed a focus tube, he directed the convergent fire of this invisible artillery on to a fixed point, an actual focus where refractory bodies, such as rubies and platinum, emitted a brilliant glow.

These brilliant experiments, which Prof. Crookes carried out some twenty years ago, made a great sensation. They were repeated at various meetings, in which many of you have no doubt taken part, and their success recalled the vogue enjoyed a century and a half ago by Abbe Nollet's experimental lessons in physics. But glory is short lived in this world; fashion changes and reputations fade. The Crookes tube soon fell into oblivion, and joined its ancestor, the "electric egg," in the glass showcases of museums. The poor neglected thing meditated for fifteen years on the inconstancy of popular favor, when one fine day it was drawn from its solitude. Hertz, guided by different opinions, took the matter up, and ascertained that the molecular bombardment traversed the aluminum screen, when this latter was not too thick. Physicists, having known for some time that thin layers of silver were opaque to ordinary light, but transparent to ultra-violet rays, saw nothing extraordinary in this. But the phenomenon became interesting from another point of view, when Lenard, making use of this transparency of aluminum, caused the cathode rays, which had until then been confined in a vacuum, to come out from the tube into the air through a small window made of this metal. The radiations, filtered through this remarkable window, excited fluorescence, acted on photographic plates, discharged electrified bodies, and even traversed sheets of black paper. All these properties, which were studied so minutely by Lenard, are precisely those which Roentgen made so famous a few months later. It is only fair to state this, in order not to allow those laborious efforts which are the usual precursors of great discoveries to be hidden from view.

Unfortunately, Lenard's rays apparatus was complex and delicate to handle, and it only gave a small beam of the curious rays. The discovery had, therefore, to be completed by the invention of a more simple apparatus, and, above all, one able to give intense and copious radiation. It was chance, that happy chance which only perspicacious observers know how to profit by, which put into Roentgen's hands the final simple and powerful apparatus. A Crookes tube, inclosed in a cardboard box, was put into action in a dark room, and a fluorescent sheet, which was by chance next to it, glowed. Roentgen noticed this, and immediately concluded that cathode rays from a simple Crookes tube are powerful enough to traverse the glass tube and thick cardboard. Photography through opaque bodies was discovered!

You know the rest. Roentgen soon devised one of the most valuable methods of investigation, to which he drew public attention by means of that somewhat grewsome picture of a transparent hand, of which the bones are visible. Surgery and pathology have been already largely benefited by the new method. Roentgen rays—since they have now received that name—reveal foreign objects in the human body hidden away under the skin, and also show affections of the bones and cartilages. They also enable the diagnosis of pleurisy to be confirmed, as our colleague, M. Bouchard, has recently announced. As the technique becomes perfected the medical applications will become easier and more widespread. Roentgen's discovery has, therefore, been called in to assist in assuaging human ailments. It is another gift to be put to the credit of pure science.

I have already rather tried your patience by speaking of these rays at such length, yet I must add some words about one of their properties which give them considerable theoretical interest. During the last few years much attention has been devoted to the relation between electricity and light. The work of Hertz has proved that electric oscillations can be propagated in air or in vacuo with a speed equal to that of light. Thus electric waves and luminous waves are motions of the same medium. Cathode rays, having the property either of discharging electrified bodies or of themselves assuming a sort of electrical charge which renders them sensible to the action of magnets, add a new link between light and electricity. There is still much which is obscurity, but one feels that physicists are on the eve of making one of those great mechanical syntheses of natural agents, similar to those which we owe to the genius of Fresnel and Ampère.

THE ARAGO MEDAL.

The Arago medal, which the Académie so seldom awards, has been given twice this year. In the first instance to our venerated colleague, M. Antoine d'Abbadie, the doyen of French explorers. The second Arago medal was presented to Lord Kelvin, the first of our foreign associates, on the occasion of the celebration of the fiftieth year of his professorship of natural philosophy at the University of Glasgow. I cannot do better than quote a passage from the speech of our colleague, M. Mascart, our delegate at the ceremony. M. Mascart said:

"On another occasion, speaking in your own name, you caused us profound emotion by declaring that you owed a debt of gratitude to our country, that our great intellects, such as Fourier, Laplace and Sadi Carnot, had been your inspirers, and that you considered France as the alma mater of your scientific youth. If the debt indeed existed, you have paid it with interest. In the labors and discoveries which form landmarks in your admirable career, one of the noblest one could dream of, you have attacked every question of that science which in English literature retains the expressive name of natural philosophy, either to contribute to the progress of theoretical conceptions or to deduce applications useful to the development of industry and the good of humanity."

Nothing could be more touching than the number and unanimity of the testimonials, brought from all parts of the world, to this descendant of a family of Irish farmers, who has won universal renown by the power of his intellect; who has rightly been raised by the suffrages of his admirers to the highest scientific dignities, and by the government of his country to the highest social rank. Nothing can be more cheering and comforting for the future than to reflect on these honors rendered by delegates of all nations to such great savants as Lord Kelvin and Pasteur, who represent science in its most elevating and at the same time in its most beneficent aspect. Although crushed beneath the yoke of material interests and the barbarous reign of blood and iron, modern nations can, on such occasions as these, lift their eyes toward serene regions shining above hatred and jealousy, and join in honoring great men whose labors increase at once the common intellectual patrimony, the prestige of their country, and the well-being of humanity.

ON THE ORIGIN AND HISTORY OF SOME DISEASE NAMES.*

By WILLIAM SYKES, M.D. Dunelm., F.S.A., a Correspondent of the New English Dictionary.

WHILE the New English Dictionary is working out in an exhaustive manner, and on historical lines, the origin, development and use of every word in the English language, it will not be amiss for members of the medical profession to review their own terminology, both as a small contribution to this monumental work and as an independent attempt to discover the principles on which certain medical terms have come into existence originally. This, again, may not be without use in settling the lines on which they may be most usually formed and developed in the future. Our vocabulary must, in the first instance, be sought out in the medical literature of all ages; not in the systems of nosology which have been so abundantly produced from the time of Cullen to the present day. The language of a profession is formed from the words actually spoken, written and read by its members, just as the language of a country consists of the words used and understood by the people, not of the inventions, suggestions, emendations and alterations of a few scholars in their studies.

The subject, indeed, under consideration is the vocabulary of the science of medicine as employed by English writers in English medical works. One cannot help noticing in the first place that, however much Latinized or Grecized the names of diseases may have been in the past, medicine has really collected her vocabulary out of every language under heaven and from every age. Folk speech dealing with rough, objective symptoms has given us no mean proportion of our disease names, folk adaptation from neighboring peoples many more, folk degradation of the language of the learned a few, while the deliberate coinage of writers has of course added largely to the list. In many instances we are able to trace the history of a medical word from its first inception and to decide at once to which of the above classes it belongs; in others we can even name the original birthplace of a word, say from what language it has been adopted, and give almost the exact date of its actual employment in our literature, yet, at the same time, be unable to perceive the reason of its adoption. The word "scarlatina" is an example of this difficulty. We believe the term to have been first used in English medical literature by the great Sydenham in his "Observationes Medicarum," published in 1676.† We also know that the word is of Italian origin, having been actually employed by an Italian writer in 1527,‡ and that it is derived from the Italian "scarlatto" (scarlet) in allusion to the color of the patient's skin; but why Sydenham, who, with the doubtful exception of a period of study at Montpellier, had never been abroad, should have inserted an Italian name amid a Latin list of maladies is difficult to explain; indeed, we have little to offer beyond conjecture.

Could Sydenham's friend, John Locke the philosopher, having seen a case of the disease in his company, have suggested to him the name bestowed upon such abroad? We know that Locke was at Montpellier about the time of the publication of this very work, and we also learn from one of Sydenham's letters § that Locke "had troubled himself in visiting with Sydenham very many of his variolous patients especially." May it have been in some communication from him at Montpellier, or elsewhere abroad, that Sydenham received an account of the malady with its name? We know, however, from that quaint but most excellent writer, James Cooke, of Warwick, that the English term "scarlet fever," as applied to this very disease, was in provincial use in Sydenham's own time. The first edition of Cooke's "Mellificium Chirurgiæ, or Marrow of Surgery," preceded that of Sydenham's "Observationes Medicarum" by a year, while its fourth edition, from which I quote, appeared only nine years later. In what edition the passage I extract was first inserted I cannot, in the absence of the earlier editions, at present ascertain. In his fourth edition, however, Cooke describes a disease he calls "rosalia," ‖ as showing "red fiery spots which break out at the beginning of the disease all over the body, as if it were a small erysipelas, though the tumor is hardly discernible." "They sometimes," he continues, "break not forth till the fourth or fifth day; in the progress of the disease they sometimes possess the whole body, so that it looks as though it were all on a red fire, which color is again changed into spots as at the beginning, which vanish upon the seventh or eighth day, the cuticle falling off in scales or great fleaks. The first and last of these [i. e., smallpox and rosalia] were at Warwick," he says, "at the writing hereof, the last going under the name of scarlet fever." It is possible, if Sydenham originally wrote his works in English, as has been stated, and was indebted to Dr. Mapletoft or another hand for his Latin translation, that he used the English term "scarlet fever" and owed the Italian "scarlatina" to his translator.

It is, at any rate, a curious fact, as Dr. Mason Good notices on Dr. Willan's authority,* that "scarlatina" was first used by British writers—as indeed has continued to be the case ever since—although Dr. Good remarks† that "in saying that the denomination scarlatina was first applied to the disease by British writers, Dr. Willan can only mean that it was by British writers first applied technically and introduced as a professional term into the medical vocabulary; for the term itself is Italian and was long a vernacular name in use on the shores of the Levant before it was imported into our own country." Be the reason of its adoption what it may, "scarlatina" affords an excellent instance of the uselessness of attempting to supplant a widely accepted disease name by some more elegant or scholarly synonym. Dr. Mason Good, in his day a great nosologist and classifier of disease, made a deliberate attempt during the early third of the present century, when his works were in vogue, to replace "scarlatina" by the old term "rosalia." He wrote‡ that "scarlatina is a barbarous and unclassical term, which has unaccountably crept into the nomenclature of medicine upon the proscription of the original and more classical name rosalia," which he states it to be his intention to restore. "It will not," he says, "be the fault of the present author if the correction so universally called for in the case before us should be postponed to another age, or the error complained of be charged upon future nosologists."

He goes on to mention De Haen, Morton, Huxham, Heberden and others as objecting to the use of the term "scarlatina," and, although he mentions Dr. Willan as employing it, he declares that even he considered it necessary to apologize for its continuance on the ground "that, however offensive the term might be to a classical ear, having been first employed by British authors, it could not well be displaced, having obtained admission into all the systems of nosology." Yet, in spite of this consensus of the opinions of great men, we find the word "scarlatina" as commonly used to-day as when Dr. Mason Good wrote, while the suggested amendments of himself and his authors are entirely forgotten, in favor of the popular term, which has become so naturalized in our language that its employment is quite as usual as its English equivalent, "scarlet fever," which is looked on by the poor as the name of a severer malady, the question being frequently asked whether a patient be suffering from "scarlet fever" or only scarlatina.

Another disease name of Italian origin is influenza, the exact date of whose introduction into British medical literature is a little uncertain. It was established in both popular and medical use during the epidemic of 1782.§ Mr. Huxham, who wrote in 1758 an account of the previous epidemic of 1743, says: "This fever seems to have been exactly the same disease as that which in the spring was rife all over Europe, termed the influenza;" while Dr. George Baker, in describing the immediately preceding epidemic of 1762, writes: "At Norwich . . . according to the testimony of the distinguished physician, William Offley . . . a much greater number fell victims than were destroyed by a similar pestilence in 1733 or by the more severe visitation, called influenza, in 1743." Dr. Watson, in a letter to Dr. Huxham dated December 9, 1762, states that "it is nearly the same disease which was at London in April and May, 1743, and then called influenza, the name applied to it in Italy." We may from this evidence assume that the term was first introduced into England during the epidemic of 1743, unless, indeed, Haser's statement, quoted by Dr. Creighton,‖ that the word was used in the title of an Edinburgh graduation thesis in Latin as early as 1703, be more than a clerical error. "Influenza," then, is a term directly imported into England from Italy and imposed on our medical terminology by popular approval. It is not quite plain, however, what the original Italian word indicated in reference to the disease. Zuelzer¶ says that it refers to the assumed influence of the atmosphere or climate, or—from the further signification of the word as something fluid, transient or fashionable—to a name commonly used in the epidemic of 1709, viz., "die Galantrie-Krankheit" or "das Modefieber."** Dr. Creighton, however, remarks†† that, while the word is usually taken to mean the influence of the stars, and may even have got that sense by popular usage, the original etymology was probably different. He points out that as early as 1554 the Venetian ambassador in London called the sweating sickness of 1551 an influsso, which is the Italian form of influxio. The latter is the correct classical term for a humor, catarrh or defluxion, the Latin defluxio itself having now a special limited meaning. It was therefore not astrology, but humoral pathology, that brought in the word influsso and influxio, out of the former of which word Dr. Creighton suspects that "influenza" grew, rather than out of any notion of influence rained down from the heavenly bodies.

All this is, however, little more than conjecture, and can only be set at rest by a resort to Italian literature

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* From London Lancet.

† Sydenham: Opera Omnia, Greenhill's edition, lib. vi, cap. ii, p. 243. Published for the Sydenham Society in 1844.

‡ Hirsch's Handbook of Geographical and Historical Pathology: New Sydenham's Society's Translations, vol. i, p. 172 (note 10).

§ Latham's Translation of Sydenham's Works (Sydenham Society's edition), vol. i, Life, p. 72.

‖ Mellificium Chirurgiæ, or Marrow of Surgery, fourth edition (1685), part vi, section ii, p. 214.

* Dr. J. Mason Good: "Study of Medicine," fourth edition, 1834, vol. ii, p. 318.

† Loc. cit., p. 318.

‡ Ibid., p. 317.

§ Thompson's Annals of Influenza, Sydenham Society's edition, p. 119 et seq.

‖ History of Epidemics in Britain, 1894, vol. ii, p. 304.

¶ Ziemssen's Cyclopedia of Medicine, English translation, vol. ii, p. 517.

** I.e., "Gallantry disease or fashionable fever."

†† Loc. cit., vol. ii, p. 304.

of the seventeenth and eighteenth centuries, an inquiry conducted on those historical lines which the "New English Dictionary" so well advocates and exemplifies. Curiously enough, the same popular caprice which placed the name "influenza" in the list of specific diseases almost succeeded in finally degrading it into a synonym of a common cold. The great epidemics of the disease in 1833 and 1847 fixed the association of the word so closely in connection with a catarrhal condition that an influenza cold became an admitted term for an ordinary cold or coryza, especially if attended with sharp fever.* It was only the present cycle of outbreak, commencing in 1889, which disassociated the name with any form of catarrh.

In or before 1782 popular favor established the name "la grippe" in as firm a condition of acceptance in France as its rival, "influenza," in England. In this, folk etymology probably assisted. "La grippe" is, according to Joseph Frank,† derived from the Polish word chrypka (raucedo), but was at once in France referred for its etymology to the French verb agripper (to seize), the sudden onset of the attack in those afflicted apparently rendering this derivation a very likely and apt one. A similar instance of transferred derivation took place in the word "dengue," as will be noted directly. Attempts have been made, entirely unsuccessfully, however, to popularize the French grippe in England in place of the Italian influenza.

With regard to the derivation of the word "dengue," it appears that the term in Spanish means fastidiousness or prudery, also a female dandy; and, as the disease dengue is, on account of neuritic or muscular pain, accompanied by a stiff, ungainly gait and awkward bearing, when it first broke out in Cuba, in 1827, no doubt was entertained that its title referred to this peculiarity, as was shown by its immediate translation in the English West Indian possessions into "dandy fever," a name it yet bears. Another popular synonym, "the giraffe," is no doubt referable to the same fact and derivation. Dr. Christie has, however, shown‡ that dengue is really a Swahili word, the full name of the disease in Zanzibar being ka dinga pepo, which may be thus construed: Ka is a partitive article meaning "a" or "a kind of;" dinga, dyenga, or denga means "a sudden cramplike seizure;" while pepo signifies "an evil spirit or plague." And it was the Swahili dinga or denga which was confused with the Spanish word dengue on the appearance of the disease in the Spanish possessions in 1827. A still more absurd explanation of the meaning of dengue than the Spanish one in question has been attempted by some of our own writers. They explain it, by an ingenious method of double beheading, to be nothing more than (A)den (A)gue.

(To be continued.)

STREETS MACADAMIZED WITH DIAMONDS.

THE costliest macadam on record is without doubt that which once paved the streets of Kimberley, South Africa, and which was so thickly studded with diamonds that millions of dollars' worth of gems were taken from it. How this princely roadbed came to be laid down is related in an interesting note in Cosmos, which the Literary Digest translates as follows: "The South African diamond mines were discovered thirty years ago, quite accidentally. A peddler who was traveling from farm to farm on his business noticed a brilliant stone among the pebbles with which some children were playing on a farm situated near the Vaal. The idea occurred to him that perhaps it might have some value. He sent it in an unsealed letter to Dr. Atherstone, of Grahamstown, who was something of a geologist; he recognized in the stone a fine diamond. The fame of this discovery grew, and soon the diamond fever led many into the fields. Mines were discovered, and a camp was quickly formed, which received the name of Kimberley.

"Water was scarce near these mines, and nevertheless it was almost indispensable for washing the diamond-bearing soil and getting the precious gems out easily. Many workmen tried to do without it and to find their diamonds in the dry earth, with the result that a great number of the stones remained in the debris of the diamond-bearing soil that had been subjected to search.

"The city of Kimberley, growing rapidly, soon had a municipal council, which, among other things, undertook to macadamize its streets. The débris, that was in the miners' way, was found excellent for this purpose. The city undertook, to the great satisfaction of great numbers of workmen, to rid them of their rubbish heaps.

"After fifteen or sixteen years, the mines became too deep to be worked by individuals; further, the almost unlimited production lowered the price of diamonds. Financiers succeeded in buying up all the mines, or rather in uniting them. The production was lessened to raise the price, machinery did the work instead of men, and many workmen were thrown out of employment. It was then remembered that the streets of Kimberley contained enormous quantities of diamonds; water brought from the river Vaal by two companies was abundant and cheap. The municipal council was petitioned by unemployed workmen for permission to wash over the macadam in the streets to recover the diamonds in it. Their request was granted, and each year a certain length of road was given over to them. These washings produced about a million francs ($200,000) worth of diamonds yearly; magnificent stones were found, and some excessively rich places. As an example, they tell of twelve square yards of street that yielded 50,000 francs ($10,000) worth of diamonds."

Adamantine Wood Protector.—Melt in an iron vessel 50 parts of rosin, and stir in 50 parts of chalk, 50 parts of fine sand, and 6 parts of linseed oil. When well mixed, add one part of copper oxide and one part of sulphuric acid, and again carefully mix. Apply to the wood hot, using a stiff brush for the purpose.—Bayerisches Indust. und Gewerbeblatt.

* Creighton: Op. cit., vol. ii, p. 304.

† Quoted in Ziemssen's Cyclopedia of Medicine, English translation, vol. ii, p. 517.

‡ Glasgow Medical Journal, September, 1861. See also New English Dictionary, under Dengue.

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